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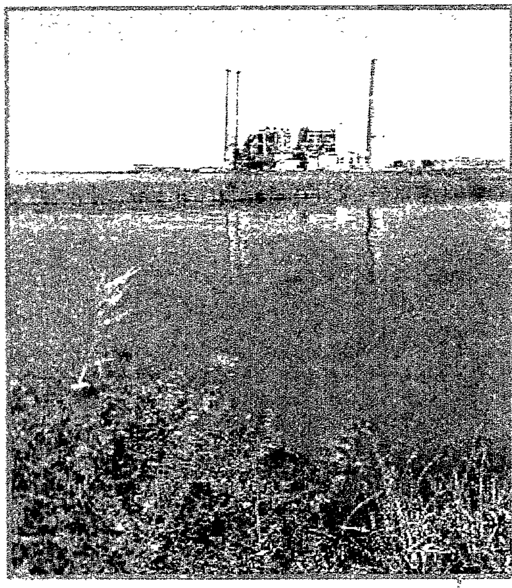
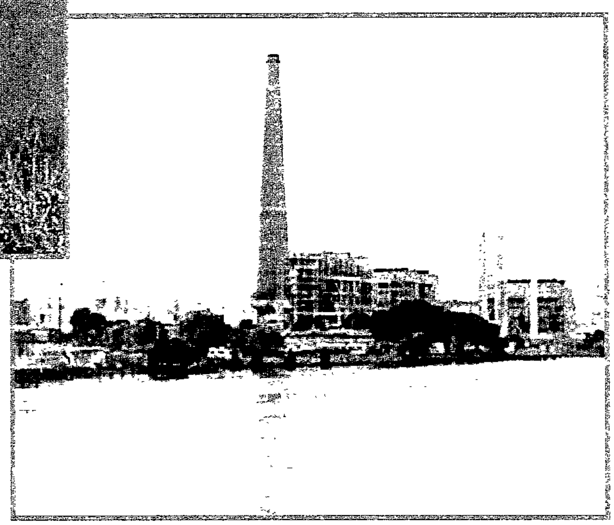
Multispecies Habitat Conservation Plan





Pittsburg and Contra Costa Power Plants

June 30, 2000

Southern Energy - California

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Southern Energy - Delta, LLC
Pittsburg and Contra Costa Power Plants

Multispecies Habitat Conservation Plan

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June 30, 2000

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SUMMARY

The goal of this Habitat Conservation Plan (HCP) is to implement a phased program that will, to the maximum extent practicable, minimize and mitigate effects of the current and future operation, maintenance, and repair of Southern Energy Delta, LLC's (SE's) Pittsburg and Contra Costa Power Plants on threatened, endangered, and other sensitive species. The primary focus of the HCP is on the sensitive fish species affected by the operation of the power plants' circulating water systems; and, secondarily, on the sensitive fish and terrestrial species affected by power plant maintenance and repair activities and by enhancement activities at the Montezuma Enhancement Site. The approval of the HCP and other related documents by the appropriate agencies will allow issuance of Incidental Take Permits for the two plants and the enhancement site.

The conservation measures are designed to minimize and mitigate the entrainment and impingement of sensitive fish species and would involve three programs

a) the construction, maintenance, monitoring and evaluation of an aquatic filter barrier (AFB) or Gunderboom™. Marine Life Exclusion System(MLES™) at the Contra Costa Power Plant;
b) reduction of cooling water flow at the Pittsburg Power Plant to minimize entrainment and impingement of sensitive fish species. Minimization of impacts caused by circulating water flows will be attained by committing to operate the circulating water pumps at the power plant intakes utilizing the variable speed drive (VSD) mode for the period of February 1 through July 31; and
c) enhancement of aquatic and terrestrial habitat at the Montezuma Enhancement Site, including the granting of a conservation easement for the 139-acre site to protect species identified in the HCP, in perpetuity.

SE's HCP is a phased conservation program designed to evaluate AFB technology which, if effective, should reduce the entrainment and impingement of sensitive aquatic species in the cooling water intake system of both the Pittsburg and Contra Costa Power Plants.

Phase I:

AFB will be installed, maintained and monitored at the Contra Costa Power Plant for a sufficient period of time to determine its efficacy at reducing or eliminating entrainment and impingement of sensitive aquatic organisms as well as evaluating the attendant impacts to other aquatic organisms. At the Pittsburg Power Plant, VSD would be implemented and evaluated from February through July. A robust biological monitoring program, conducted in consultation with the U.S. Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), and the California

Department of Fish & Game (CDFG) would determine whether or not AFB is effective and efficient at reducing or eliminating the entrainment and impingement of aquatic organisms.

Phase II:

If the results of the biological monitoring and sampling program at Contra Costa Power Plant demonstrate that the AFB technology is effective at minimizing the impacts to aquatic organisms, such technology would then be installed, maintained, monitored and evaluated at the Pittsburg Power Plant. The AFB technology would then replace the VSD technology. If, on the other hand, AFB is determined not to be effective at minimizing impacts to aquatic organisms, then the AFB would be removed and VSD would be implemented at both power plants.

Phase III:

In phase III, SE would undertake habitat conservation and enhancement activities at the Montezuma Enhancement Site (MES), which has been designed to increase the availability of nearshore habitat used by sensitive aquatic species as well as identified terrestrial species. A conservation easement would be conveyed, in perpetuity, for the MES.

Aquatic Filter Barrier

The AFB is, in essence, a curtain-like barrier that would hang in the water column and extend to the substrate. The AFB is a filter fabric comprised of a nonwoven polypropylene/polyester material with small melted holes that allows water to pass through the curtain but which prevents aquatic organisms from passing through the barrier. Because the AFB is designed to allow for very slow water pass-through rates, it has a low probability of impinging aquatic life-forms. An AFB has been used successfully on the Hudson River in New York to reduce the entrainment and impingement of fish species. (Applied Science Associates 1999) The AFB would be placed in front of the Contra Costa Units 6&7 Cooling Water Intake structure to prevent sensitive aquatic species from entering the cooling water intake. An intensive biological monitoring program would be implemented to determine the effectiveness of the AFB at the Contra Costa Power Plant.

Variable Speed Drive

SE will use VSD to reduce cooling water flow rates to minimize impacts to sensitive aquatic organisms that may otherwise be subject to entrainment and impingement. Minimization of impacts caused by circulating water flows will be attained by committing to operate the circulating water pumps at the power plant intakes utilizing the VSD mode for the period of February 1 through July 31. Under normal operations, the circulating water pumps are operated at full capacity, regardless of the units' generation output. When the circulating water pumps are operated in the VSD mode, the intake of circulating water can be reduced by reducing the speed of the circulating water pumps when the units run at lower loads. By reducing the intake of water, the entrainment and impingement of sensitive species is reduced; however, the ability to produce power is also significantly reduced.

The target reduction threshold for cooling water intake at the Pittsburg Power Plant Units 1-7 is 20% below design flow and at the Contra Costa Power Plant 5% below design flow for Units 6 and 7 and 100% reduction for Units 1-5. If electrical energy demands require the units to be taken out of VSD mode and target thresholds are exceeded, mitigation compensation is required. The mitigation compensation provides funding for aquatic habitat restoration for the species listed in the HCP.

Montezuma Enhancement Site

The HCP also specifies that aquatic and terrestrial habitat enhancement is required at the Montezuma Enhancement Site. A conservation easement for the 139-acre site will be conveyed to protect species identified in the HCP in perpetuity

Potential impacts on threatened, endangered, and sensitive species resulting from power plant operation have prompted SE to develop several conservation measures designed to help protect such species. SE has formalized these conservation measures in this HCP. The HCP will be submitted, in part, to obtain an incidental take permit under Section 10(a)(1)(B) of the federal Endangered Species Act (ESA) and an appropriate take authorization from the California Department of Fish and Game (CDFG). This HCP is designed to mitigate the take as defined by the ESA and the California Endangered Species Act (CESA) of the following threatened and endangered species: Delta smelt, Sacramento River winter-run ESU (ESU refers to evolutionary significant unit) chinook salmon, Central Valley spring-run ESU chinook salmon, Central Valley ESU steelhead, and Sacramento splittail. This HCP is designed to mitigate the take as defined by the ESA of suitable habitat of the following threatened and endangered species: California black rail, California clapper rail, California least tern, and salt marsh harvest mouse. All effects on threatened and endangered species will occur as a result of otherwise lawful power plant activities. Threatened or endangered species addressed in this HCP will be listed on the incidental take permits(ITP). Incidental take authorization for these species will be effective upon permit issuance.

The HCP also addresses potential impacts of take on unlisted special-status species, including longfin smelt, Central Valley fall/late fall run ESU chinook salmon, green sturgeon, and the plant species soft bird's-beak. Except for the Central Valley fall/late-fall run chinook salmon and the green sturgeon, the unlisted species addressed in this HCP will also be listed on the incidental take permits and the authorization for these species will be effective upon their future listing as threatened or endangered. In the case of the Central Valley fall/late-fall run chinook salmon and the green sturgeon, these species will not be listed on the incidental take permits and in the event of their future listing as threatened or endangered, amendments to the take permits will be required.

The activities covered by this HCP include cooling water intake and discharge, including AFB, operation, maintenance and repair and fisheries monitoring activities at the power plants, and the enhancement and restoration activities at the Montezuma Enhancement Site The term of the HCP and 10(a) permit is 15 years from the date of the issuance. It is the intent of this process to obtain separate take permits for the two facilities. Consequently, each power plant is discussed separately in this document.

APPLICABLE LAW

The ESA provides protection for endangered and threatened species. Section 9 of the ESA prescribes civil and criminal penalties for the take of a protected species except when the take is in accordance with a valid permit issued under Section 10 (a)(1)(B) of the ESA.

The California Fish and Game Code also prohibits take of state-listed threatened or endangered species. The CDFG's participation in the HCP will address state-listed threatened and endangered species and facilitate the appropriate state take authorization as well as address the impacts on candidate species under Section 2084 of the California Fish and Game Code. The HCP is intended to meet the requirements of the federal and state endangered species acts. In addition, an Environmental Assessment (EA) has been prepared pursuant to the National Environmental Policy Act and California Environmental Quality Act.

SPECIES ADDRESSED

Species addressed by this HCP are the federally listed threatened or endangered plants and animals and state-listed animals shown below. Unlisted species addressed by this HCP are the species that either are proposed for federal listing or have been identified as species of concern. A plant species is included below and is also addressed in the HCP, even though the prohibition on take of plants under the ESA (Section 9(a)(2)(B)) does not apply to plants found on private property unless the take is a violation of state law. By addressing sensitive plants within the HCP, the potential for obtaining a jeopardy opinion related to plants is minimized during the required Section 7 consultation between the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) on the Section 10 permit application. The issuance of a jeopardy opinion would prevent the permit from being issued.

Listed Species

Fish	Plants	Wildlife
Delta smelt (FT, ST)	Soft bird's-beak (FPE, SR)	California black rail (ST)
Sacramento River winter-run ESU chinook salmon (FE, SE)		California clapper rail (FE, SE)
Central Valley spring-run salmon (FT, ST)		
Central Valley ESU steelhead (FT)		California least tern (FE, SE)
Sacramento splittail (FT)		Salt marsh harvest mouse (FE, SE)

F = Federal: **S** = State; **E** = Endangered; **T** = Threatened; **R** = Rare; **FPE** = Federally proposed for listing as endangered.

Unlisted Species

Fish
Longfin smelt (SOC)
Central Valley fall/late fall-run ESU chinook salmon (FC)
Green sturgeon (SOC)

F = Federal; **S** = State; **FPT** = Federally proposed for listing as threatened; **FPE** = Federally proposed for listing as endangered; **SOC** = Species of concern; **FC**= Federal candidate for listing.

TAKE AND MITIGATION

The operation, maintenance, and repair of SE's Pittsburg and Contra Costa Power Plants may result in the incidental take of some of the species. Under the ESA, take is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Under CESA, take is defined as to "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill." Take may result from impact on aquatic species due to the intake of water for condenser cooling (part of the process of generating electricity at the power plants), from the impact on suitable habitat for terrestrial species associated with repair and maintenance activities, and with restoration and enhancement of the Montezuma Enhancement Site. The Implementing Agreements have been developed, as required by the ESA, between SE, USFWS, and NMFS to define the rights and responsibilities of the parties to the HCP (refer to Appendix G-1 and G-2).

The ITP would make the incidental take of federally listed species lawful as long as it is in accordance with the conditions described in the HCP and the Implementing Agreement. The federal permits will cover the listed species addressed in the HCP and listed on the permits and incidental take authorization for those species will be effective at the time of permit issuance. The federal permits will also cover the unlisted species addressed in this HCP and listed on the permits and individual take authorization for those species will become effective if and when the species are listed as threatened or endangered. The Central Valley fall/late-fall run chinook salmon and the green sturgeon are addressed in this HCP but will not be listed in the permits, and in the event they are listed in the future as threatened or endangered, permit amendments will be required.

SE will continue to work with the CDFG to implement appropriate measures to avoid, minimize, and compensate to the extent practicable impacts on state-listed species addressed in the HCP. SE will also work with the CDFG to obtain either a consistency determination with regard to the federally-issued ITP or obtain independent approval from the CDFG.

PITTSBURG POWER PLANT

The federal Section 10(a)(1)(B) permit and state 2081 authorizes the incidental take of the species listed in Table S-1. Table S-1 and S-2 reflects the maximum potential take at the Pittsburg Power Plant, assuming that VSD technology is the primary conservation measure implemented to minimize entrainment of sensitive aquatic organisms at that plant. On the other hand, if AFB is demonstrated effective at the Contra Costa Power Plant in Phase I of the HCP, then AFB would be implemented at the Pittsburg Power Plant during Phase II. If AFB is implemented at Pittsburg Power Plant, potential take should be substantially reduced. Based on use of the AFB technology on the Hudson River, SE believes that an eighty to ninety-nine percent reduction in entrainable organisms is possible. The implementation of AFB at the Pittsburg Power Plant would, however, coincide with a robust biological monitoring and sampling program developed in consultation with a biological monitoring team comprised of USFWS, NMFS, and CDFG. A final AFB biological monitoring and sampling program for the Pittsburg Power Plant will be developed in consultation with USFWS, NMFS, and CDFG based on results learned from the AFB monitoring at the Contra Costa Power Pant (a biological monitoring and sampling plan for Contra Costa Power Plant is included in Appendix H). Although a monitoring plan for the Pittsburg Power Plant is not yet developed, it is anticipated that at least during initial installation of AFB the biological monitoring program may increase the take of listed species approximately three-fold from the amount listed in the fourth column (Monitoring Activities) of Table S-1.

Table S-1. Maximum Potential Take of Federally Listed Species, Pittsburg Power Plant Under VSD

FEDERALLY LISTED SPECIES	Maximum potential take[1]		
	Maintenance and repair activities	Operation activities	Monitoring activities
Delta smelt	The number of individuals supported by 150 ac-ft of water.	Annually, the number of individuals within 18,250 ac-ft of water diverted for condenser cooling for each 7-day running average from February 1 - July 31, or a total of 474,000 ac-ft of water for condenser cooling, and an estimated 21,000 ac-ft of water for station service water and auxiliary pump flow for a combined total of 495,000 ac-ft for the February-July time period; and approximately 600,000 ac-ft of water for condenser cooling and an estimated 21,000 ac-ft of water for station service water and auxiliary pump flow for a combined total of 621,000 ac-ft of water for the remainder of the year.	The number of individuals supported by approximately 525 ac-ft of water. The maximum estimated take would be 58 individuals over the 15-year period.[2]
Sacramento River winter-run ESU chinook salmon	The number of individuals supported by 150 ac-ft of water.	Annually, the number of individuals within 18,250 ac-ft of water diverted for condenser cooling for each 7-day running average from February 1 - July 31, or a total of 474,000 ac-ft of water for condenser cooling, and an estimated 21,000 ac-ft of water for station service water and auxiliary pump flow for a combined total of 495,000 ac-ft for the February-July time period; and approximately 600,000 ac-ft of water for condenser cooling and an estimated 21,000 ac-ft of water for station service water and auxiliary pump flow for a combined total of 621,000 ac-ft of water for the remainder of the year.	The number of individuals supported by approximately 525 ac-ft of water. No winter-run salmon are expected to be collected during this effort. If a winter-run is collected, NMFS and CDFG will be notified immediately. Sampling may be continued after coordination with NMFS and CDFG.
Central Valley spring-run ESU chinook salmon	The number of individuals supported by 150 ac-ft of water.	Annually, the number of individuals within 18,250 ac-ft of water diverted for condenser cooling for each 7-day running average from February 1 - July 31, or a total of 474,000 ac-ft of water for condenser cooling, and an estimated 21,000 ac-ft of water for station service water and auxiliary pump flow for a combined total of 495,000 ac-ft for the February-July time period; and approximately 600,000 ac-ft of water for condenser cooling and an estimated 21,000 ac-ft of water for station service water and auxiliary pump flow for a combined total of 621,000 ac-ft of water for the remainder of the year.	The number of individuals supported by approximately 525 ac-ft of water. No spring-run chinook salmon are expected to be taken during this effort. The maximum take could range from 0-15 individuals over the 15-year period.
Central Valley ESU steelhead	The number of individuals supported by 150 ac-ft of water.	Annually, the number of individuals within 18,250 ac-ft of water diverted for condenser cooling for each 7-day running average from February 1 - July 31, or a total of 474,000 ac-ft of water for condenser cooling, and an estimated 21,000 ac-ft of water for station service water and auxiliary pump flow for a combined total of 495,000 ac-ft for the	The number of individuals supported by approximately 525 ac-ft of water. No steelhead are expected to be taken during this effort. The maximum take could range from 0-15 individuals over the 15-year period.

FEDERALLY LISTED SPECIES	Maximum potential take[1]		
	Maintenance and repair activities	Operation activities	Monitoring activities
		February-July time period; and approximately 600,000 ac-ft of water for condenser cooling and an estimated 21,000 ac-ft of water for station service water and auxiliary pump flow for a combined total of 621,000 ac-ft of water for the remainder of the year.	
Sacramento splittail	The number of individuals supported by 150 ac-ft of water.	Annually, the number of individuals within 18,250 ac-ft of water diverted for condenser cooling for each 7-day running average from February 1 - July 31, or a total of 474,000 ac-ft of water for condenser cooling, and an estimated 21,000 ac-ft of water for station service water and auxiliary pump flow for a combined total of 495,000 ac-ft for the February-July time period; and approximately 600,000 ac-ft of water for condenser cooling and an estimated 21,000 ac-ft of water for station service water and auxiliary pump flow for a combined total of 621,000 ac-ft of water for the remainder of the year.	The number of individuals supported by approximately 525 ac-ft of water. The maximum estimated take would be 56 individuals over the 15 year period.
California clapper rail[3]	The temporary or permanent loss of 1.5 acres of suitable habitat.	None	None[5]
California least tern[3]	The temporary or permanent loss of 0.7 acres of suitable habitat.[4] Take is expected to be the number of observations or disturbance events, and not mortality of individuals.	None	None[5]
Salt marsh harvest mouse[3]	The temporary or permanent loss of 0.75 acres of suitable habitat.	None	None[5]

1 Take is defined under the ESA as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Estimates of take of individuals are maximums, and are not expected to occur.
2 Based on the actual maximum number of fish collected during the 1986-92 sampling efforts, and represents the expected take for the 15-year permit period under the sampling conducted as required by the CDFG Striped Bass Agreement.
3 Take of terrestrial species is not expected to result in mortalities of individuals.
4 For purposes of complying with the ESA, it is estimated that 0.7 acres of suitable habitat has the potential to support a maximum of 8 breeding pairs and 24 eggs.
5 Monitoring activities will be covered under separate federal and state scientific collection permits.

Actual biological monitoring for all aquatic and terrestrial species listed in the HCP at the Pittsburg Power Plant will be conducted according to an approved plan using USFWS, NMFS and CDFG protocols and conducted by a qualified biologist holding appropriate federal and California scientific collection permits. A conceptual biological monitoring plan reviewed and developed in consultation with the USFWS, NMFS and the CDFG is provided in Appendix H.

In addition, the HCP addresses the following species that are found at the Pittsburg Power Plant site that are not federally listed, but are either proposed for listing or have been assigned a significant level of pre-listing status (Table S-2).

Table S-2. Maximum Potential Take of Unlisted Species, Pittsburg Power Plant Under VSD

SPECIES UNLISTED UNDER THE ESA	Maximum Potential Take[1]		
	Maintenance and Repair Activities	Operation Activities	Monitoring Activities
Longfin smelt	The number of individuals supported by 150 ac-ft of water.	Annually, the number of individuals within 18,250 ac-ft of water diverted for condenser cooling for each 7-day running average from February 1 - July 31, or a total of 474,000 ac-ft of water for condenser cooling, and an estimated 21,000 ac-ft of water for station service water and auxiliary pump flow for a combined total of 495,000 ac-ft for the February-July time period; and approximately 600,000 ac-ft of water for condenser cooling and an estimated 21,000 ac-ft of water for station service water and auxiliary pump flow for a combined total of 621,000 ac-ft of water for the remainder of the year.	The number of individuals supported by approximately 525 ac-ft of water. The maximum estimated take would be 260 individuals over the 15 year period.[2]
Central Valley fall/late fall-run ESU chinook salmon	The number of individuals supported by 150 ac-ft of water.	Annually, the number of individuals within 18,250 ac-ft of water diverted for condenser cooling for each 7-day running average from February 1 - July 31, or a total of 474,000 ac-ft of water for condenser cooling, and an estimated 21,000 ac-ft of water for station service water and auxiliary pump flow for a combined total of 495,000 ac-ft for the February-July time period; and approximately 600,000 ac-ft of water for condenser cooling and an estimated 21,000 ac-ft of water for station service water and auxiliary pump flow for a combined total of 621,000 ac-ft of water for the remainder of the year.	The number of individuals supported by approximately 525 ac-ft of water. No *late-fall-run chinook* salmon are expected to be taken during this effort. The maximum take could range from 0-15 individuals over the 15-year period.
Green sturgeon	The number of individuals supported by 150 ac-ft of water.	Annually, the number of individuals within 18,250 ac-ft of water diverted for condenser cooling for each 7-day running average from February 1 - July 31, or a total of 474,000 ac-ft of water for condenser cooling, and an estimated 21,000 ac-ft of water for station service water and auxiliary pump flow for a combined total of 495,000 ac-ft for the February-July time period; and approximately 600,000 ac-ft of water for condenser cooling and an estimated 21,000 ac-ft of water for station service water and auxiliary pump flow for a combined total of 621,000 ac-ft of water for the remainder of the year.	The number of individuals supported by approximately 525 ac-ft of water. No green sturgeon are expected to be taken during this effort. The maximum take could range from 0-15 individuals over the 15 year monitoring period.
California black rail[3]	The temporary or permanent loss of 1.5 acres of suitable habitat.	None	The temporary or permanent loss of 1.5 acres of suitable habitat.
Soft bird's-beak	The number of individuals supported by 0.75 acre of suitable habitat over 15 years.	None	None

[1] Take is defined under the ESA as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Estimates of take of individuals are maximums, and are not expected to occur.
[2] Based on the actual maximum number of fish collected during the 1986-92 sampling efforts, and represents the expected take for the 15-year permit period under the sampling conducted as required by the CDFG Striped Bass Agreement.
[3] Take of terrestrial species is not expected to result in mortalities of individuals.

CONTRA COSTA POWER PLANT

The federal Section 10(a)(1)(B) permit and state take authorization would cover the maximum incidental take of the species listed in Table S-3 assuming that AFB is ineffective and VSD technology is the primary conservation measure.

Tables S-3 and S-4 reflect the maximum potential take at the Contra Costa Power Plant, assuming that VSD technology is the primary conservation measure implemented to minimize entrainment of sensitive aquatic organisms.. If the AFB is determined to be effective during the Phase I demonstration, then VSD will not be implemented at the Contra Costa Power Plant, and AFB will be the designated minimization method. If the AFB is fully functional, entrainment of aquatic organisms in the cooling water should be substantially reduced. As noted, if the AFB functions as expected, entrainment of sensitive aquatic species should be reduced by 80-90 percent. The implementation of AFB at the Contra Costa Power Plant would, however, coincide with a more robust biological monitoring and sampling program. A biological monitoring and sampling program for the Contra Costa Power Plant was developed in consultation with NMFS, USFWS and CDFG, and is attached in Appendix H. It is anticipated that, at least during initial installation of AFB, the biological monitoring program may increase the take of listed species approximately 6 to 8 fold from the take listed in the fourth column of Tables S-3 and S-4 (Monitoring Activities).

Table S-3. Maximum Potential Take of Federally Listed Species, Contra Costa Power Plant Under VSD

FEDERALLY LISTED SPECIES	Maximum Potential Take[1]		
	Maintenance and Repair Activities	Operation Activities[2]	Monitoring Activities
Delta smelt	The number of individuals supported by 150 ac-ft of water.	Annually, the number of individuals within 8,970 ac-ft of water diverted for condenser cooling for each 7-day running average from February 1 - July 31 (for Units 6 & 7), or a total of 233,000 ac-ft of water for condenser cooling, and an estimated 8,000 ac-ft of water for station service water and auxiliary pump flow for a combined total of 241,000 ac-ft for the February-July time period; and approximately 248,000 ac-ft of water for condenser cooling and an estimated 8,000 ac-ft of water for station service and auxiliary pump flow for a combined total of 256,000 ac-ft of water for the remainder of the year.	The number of individuals supported by approximately 525 ac-ft of water. The maximum estimated take would be 118 individuals over the 15-year period.[3]
	The number of individuals supported by 150 ac-ft of water.	Annually, the number of individuals within 8,970 ac-ft of water diverted for condenser cooling for each 7-day running average from February 1 - July 31 (for Units 6 & 7), or a total of 233,000 ac-ft of water for condenser cooling, and an estimated 8,000 ac-ft of water for station service water and auxiliary pump flow for a combined total of 241,000 ac-ft for the February-July time period; and approximately 248,000 ac-ft of water for condenser cooling and an estimated 8,000 ac-ft of water for station service and auxiliary pump flow for a combined total of 256,000 ac-ft of water for the remainder of the year.	The number of individuals supported by approximately 525 ac-ft of water. No winter-run salmon are expected to be collected during this effort. If a winter-run specimen is collected, NMFS and CDFG will be notified immediately. Sampling may be continued after coordination with NMFS and CDFG.
Central Valley spring-run ESU chinook salmon	The number of individuals supported by 150 ac-ft of water.	Annually, the number of individuals within 8,970 ac-ft of water diverted for condenser cooling for each 7-day running average from February 1 - July 31 (for Units 6 & 7), or a total of 233,000 ac-ft of water for condenser cooling, and an estimated 8,000 ac-ft of water for station service water and auxiliary pump flow for a combined total of 241,000 ac-ft for the February-July time period; and approximately 248,000 ac-ft of water for condenser cooling and an estimated 8,000 ac-ft of water for station service and auxiliary pump flow for a combined total of 256,000 ac-ft of water for the remainder of the year.	The number of individuals supported by approximately 525 ac-ft of water. No spring-run chinook salmon are expected to be taken during this effort. The maximum take could range from 0-15 individuals over the 15-year period.[3]

FEDERALLY LISTED SPECIES	Maximum Potential Take[1]		
	Maintenance and Repair Activities	Operation Activities[2]	Monitoring Activities
	The number of individuals supported by 150 ac-ft of water.	Annually, the number of individuals within 8,970 ac-ft of water diverted for condenser cooling for each 7-day running average from February 1 - July 31 (for Units 6 & 7), or a total of 233,000 ac-ft of water for condenser cooling, and an estimated 8,000 ac-ft of water for station service water and auxiliary pump flow for a combined total of 241,000 ac-ft for the February-July time period; and approximately 248,000 ac-ft of water for condenser cooling and an estimated 8,000 ac-ft of water for station service and auxiliary pump flow for a combined total of 256,000 ac-ft of water for the remainder of the year.	The number of individuals supported by approximately 525 ac-ft of water. No steelhead are expected to be taken during this effort. The maximum take could range from 0-15 individuals over the 15-year period. [3]
Sacramento splittail	The number of individuals supported by 150 ac-ft of water.	Annually, the number of individuals within 8,970 ac-ft of water diverted for condenser cooling for each 7-day running average from February 1 - July 31 (for Units 6 & 7), or a total of 233,000 ac-ft of water for condenser cooling, and an estimated 8,000 ac-ft of water for station service water and auxiliary pump flow for a combined total of 241,000 ac-ft for the February-July time period; and approximately 248,000 ac-ft of water for condenser cooling and an estimated 8,000 ac-ft of water for station service and auxiliary pump flow for a combined total of 256,000 ac-ft of water for the remainder of the year.	The number of individuals supported by approximately 525 ac-ft of water. The maximum estimated take would be 17 individuals over the 15 year permit period. [3]

1 Take is defined under the ESA as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.@ Estimates of take of individuals are maximums, and are not expected to occur.

2 The flow volumes reflect separate operation of Contra Costa Units 6 and 7 and Units 1-5.

3 Based on the actual maximum number of fish collected during the 1986-92 sampling efforts, and represents the expected take for the 15-year permit period under the sampling conducted as required by the CDFG Striped Bass Agreement.

In addition, the HCP addresses the following sensitive species found at the Contra Costa Power Plant site that are either proposed for listing or have been assigned a significant level of pre-listing status (Table S-4).

Table S-4. Maximum Potential Take of Unlisted Species, Contra Costa Power Plant Under VSD

SPECIES UNLISTED UNDER THE ESA	Maximum Potential Take[1]		
	Maintenance and Repair Activities	Operation Activities[2]	Monitoring Activities
Longfin smelt	The number of individuals supported by 150 ac-ft of water.	Annually, the number of individuals within 8,970 ac-ft of water diverted for condenser cooling for each 7-day running average from February 1 - July 31 (for Units 6 & 7), or a total of 233,000 ac-ft of water for condenser cooling, and an estimated 8,000 ac-ft of water for station service water and auxiliary pump flow for a combined total of 241,000 ac-ft for the February-July time period; and approximately 248,000 ac-ft of water for condenser cooling and an estimated 8,000 ac-ft of water for station service and auxiliary pump flow for a combined total of 256,000 ac-ft of water for the remainder of the year.	The number of individuals supported by approximately 525 ac-ft of water. The maximum estimated take would be 178 individuals over the 15 year permit period.
Central Valley fall/late fall-run ESU chinook salmon	The number of individuals supported by 150 ac-ft of water.	Annually, the number of individuals within 8,970 ac-ft of water diverted for condenser cooling for each 7-day running average from February 1 - July 31 (for Units 6 & 7), or a total of 233,000 ac-ft of water for condenser cooling, and an estimated 8,000 ac-ft of water for station service water and auxiliary pump flow for a combined total of 241,000 ac-ft for the February-July time period; and approximately 248,000 ac-ft of water for condenser cooling and an estimated 8,000 ac-ft of water for station service and auxiliary pump flow for a combined total of 256,000 ac-ft of water for the remainder of the year.	The number of individuals supported by approximately 525 ac-ft of water. No late-fall-run chinook salmon are expected to be taken during this effort. The maximum take could range from 0-15 individuals over the 15-year period.[3]
Green sturgeon	The number of individuals supported by 150 ac-ft of water.	Annually, the number of individuals within 8,970 ac-ft of water diverted for condenser cooling for each 7-day running average from February 1 - July 31 (for Units 6 & 7), or a total of 233,000 ac-ft of water for condenser cooling, and an estimated 8,000 ac-ft of water for station service water and auxiliary pump flow for a combined total of 241,000 ac-ft for the February-July time period; and approximately 248,000 ac-ft of water for condenser cooling and an estimated 8,000 ac-ft of water for station service and auxiliary pump flow for a combined total of 256,000 ac-ft of water for the remainder of the year.	The number of individuals supported by approximately 525 ac-ft of water. No green sturgeon are expected to be taken during the 15 year monitoring period. The maximum take could range from 0-15 individuals. [3]

[1] Take is defined under the ESA as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Estimates of take of individuals are maximums, and are not expected to occur.

[2] The flow volumes reflect separate operation of Contra Costa Units 6 and 7 and Units 1-5.

[3] Based on the actual maximum number of fish collected during the 1986-92 sampling efforts, and represents the expected take for the 15-year permit period under the sampling conducted as required by the CDFG Striped Bass Agreement.

MONTEZUMA ENHANCEMENT SITE

The federal Section 10(a)(1)(B) permit and state take authorization would cover the incidental take of the species listed in Table S-5.

Table S-5. Maximum Potential Take of Federally Listed Species, Montezuma Enhancement Site

FEDERALLY LISTED SPECIES	Maximum potential take[1] from restoration and Enhancement activities[2]
Delta smelt	The number of individuals supported by approximately 1 ac-ft of water.
Sacramento River winter-run ESU chinook salmon[3]	The number of individuals supported by approximately 1 ac-ft of water.
Central Valley ESU steelhead	The number of individuals supported by approximately 1 ac-ft of water.
Central Valley spring-run ESU chinook salmon	The number of individuals supported by approximately 1 ac-ft of water.
Sacramento splittail	The number of individuals supported by approximately 1 ac-ft of water.
Salt marsh harvest mouse[3]	The temporary or permanent loss of 10 acres of suitable habitat.

[1] Take is defined under the ESA as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.@ Estimates of take of individuals are maximums, and are not expected to occur.
[2] Restoration and enhancement activities will be scheduled during the September 1-March 1 period.
[3] Take of species is not expected to result in mortalities of individuals.

Monitoring for all aquatic and terrestrial species listed in the HCP at the Montezuma Enhancement Site will be conducted according to approved USFWS/NMFS/CDFG protocols and will be conducted by a qualified biologist holding appropriate federal and California scientific collection permits.

In addition, the HCP addresses the following sensitive species found at the Montezuma Enhancement Site that are either proposed for listing or have been assigned a significant level of pre-listing status (Table S-6).

Table S-6. Maximum Potential Take of Unlisted Species, Montezuma Enhancement Site

SPECIES UNLISTED UNDER THE ESA	Maximum potential take[1] from restoration and enhancement activities
Longfin smelt	The number of indivi[illegible]s supported by approximately 1 ac-ft of water.
Central Valley fall/late fall-run ESU chinook salmon	The number of individuals supported by approximately 1 ac-ft of water.
Green sturgeon	The number of individuals supported by approximately 1 ac-ft of water.
California black rail	The temporary or permanent loss of 57 acres of suitable habitat.

[1] Take is defined under the ESA as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.@ Estimates of take of acre-feet of water are expected to result in minimal mortalities of individuals.

HCP CONSERVATION MEASURES: MINIMIZATION, HABITAT ENHANCEMENT AND PROTECTION

This HCP describes conservation measures designed to eliminate, reduce, or compensate for the effects of the operation, maintenance, and repair of the power plants on sensitive species in the HCP Area. The HCP includes measures suggested by the USFWS and NMFS as being desirable, necessary or appropriate for purposes of the HCP. The protection measures generally benefit sensitive plant and wildlife species, while the minimization measures generally benefit sensitive aquatic species. Habitat enhancement measures generally benefit all the sensitive species.

Power plant minimization and mitigation measures include:

- Implementing an Aquatic Filter Barrier ("AFB") at the Contra Costa Power Plant with the goal of effectively reducing the entrainment and impingement in Phase I larval, juvenile, and adult stages of listed and sensitive aquatic species. If the biological monitoring and sampling program demonstrates that the AFB is effective, the AFB technology will then be implemented at the Pittsburg Power Plant in Phase II. If the AFB technology is not demonstrated to be effective at significantly reducing or eliminating entrainment or impingement at either or both power plants, variable speed drive (VSD) will be implemented at one or both the Pittsburg and Contra Costa Power Plants as described below.

- During Phase I, the VSD program will reduce the volume of circulating water flows through the Pittsburg Power Plant from February 1 through July 31 of each calendar year by operating the circulating water pumps under variable speed drive (VSD) mode. The target circulating water flow reduction threshold for the Pittsburg Power Plant will be 20% below design capacity from February 1 through July 31 of each calendar year measured on a 7-day running average. If the AFB is demonstrated to be effective in Phase I at the Contra Costa Power Plant, then VSD will be phased out at the Pittsburg Power Plant and AFB will be installed.

- The VSD program, if it is implemented in lieu of AFB at the Contra Costa Power Plant, will reduce the volume of circulating water flows through the plant from February 1 through July 31 of each calendar year by operating the circulating water pumps under variable speed drive (VSD) mode. The target circulating water flow reduction threshold for the Contra Costa Power Plant will be 5% below design capacity for Units 6 and 7 and a 100% reduction below design capacity for Units 1-5 (an overall reduction of 57% for Units 1-7) from February 1 through July 31 of each calendar year measured on a 7-day running average.

- Under VSD operation, load demands may require the units to be taken out of VSD mode, and the threshold levels for circulating water flow may be exceeded. If flow exceeds the threshold levels based on a 7-day running average, SE will be required to mitigate through a scheduled compensation amount described in Appendix F. All mitigation compensation will be provided to an endowment fund dedicated to fishery restoration and enhancement activities. Those activities will be reviewed and approved by USFWS, NMFS, and CDFG. No mitigation compensation will be required during AFB minimization.

- Under VSD operation, rotating and cleaning intake screen assemblies for all screen assemblies in operation at the Pittsburg and Contra Costa Power Plants from February 1 through July 31 at a frequency of about every 4 hours to maintain intake water velocities as close as practicable to design levels. Under AFB minimization, intake screens will be maintained for backup, but will not have a set operation schedule.

Habitat enhancement measures include:

- SE will convey a Conservation Easement pertaining to the real property commonly known as the Montezuma site, County of Solano, consisting of approximately 139 acres of undeveloped land to a Conservation Entity for the conservation and protection of the sensitive species identified in this plan. The conservation easement shall be conveyed to CDFG upon completion of habitat enhancement activities on site. Such easement will remain in effect in perpetuity.

- SE will restore tidal flow at the Montezuma site by creating openings (about 100 ft in width) at the Sacramento River and Marshall Cut.

- SE will recontour portions of the Montezuma site to create three dead-end sloughs of approximately 50 ft in width and 350 ft in length.

- SE will recontour the three constructed dead-end sloughs on the Montezuma site to increase the available tidal, intertidal, and upper tidal zones.

- SE will increase the quantity and enhance the quality of northern coastal salt marsh and coastal brackish marsh on the Montezuma site.

- The amount of funding to be contributed by SE to complete the restoration and enhancement of the Montezuma site is described in Section 7 of this HCP.

- SE and any successor or assign shall maintain existing fencing to control access to the site.

Protection measures include:

- Maintaining fencing and controlled access.

- Keeping vehicles on access roads. A 15-mph speed limit shall be observed on unpaved access roads.

- Prohibiting firearms except for those used by security personnel.

- Prohibiting the feeding of wildlife.

- Prohibiting the collection of plant or wildlife species.

- Prohibiting littering.

- Providing an employee training program for all personnel working within the HCP Area. The program, subject to review and approval by the USFWS, NMFS, and CDFG, will consist of a brief discussion of endangered species biology and the legal protections afforded these species, a discussion of the biology of the Sensitive Species addressed in the HCP, the habitat requirements of these species, their status under the federal Endangered Species Act and the California Endangered Species Act, measures being taken for the protection of these species and their habitats under the HCP, and a review of the minimization and compensation measures. A fact sheet conveying this information will also be distributed to all employees working in the HCP Area.

- If a population of soft bird's-beak must be cleared to comply with fire clearance criteria, SE will salvage and transplant the individual or population to a suitable location within the HCP Area.

- Locating staging and storage areas for equipment and materials on previously disturbed sites.

- All scheduled repair and maintenance activities within potential California black rail and California clapper rail habitat in the Pittsburg Power Plant HCP Area will be restricted to the period September 1 to January 31 unless preceded by sensitive species surveys using agency approved protocols. All maintenance and repair activity within the potential salt marsh harvest mouse habitat year-round will be preceded by sensitive species surveys using agency-approved protocols. These restrictions will reduce potential conflicts with these species during the reproductive season, except in case of emergency, as defined in Section 6-1.3.

- All repair and maintenance activities of the Pittsburg Unit 7 circulating water cooling canal adjacent to nesting areas will be restricted to the period September 1 through March 31 to minimize potential impacts on California least terns, except in case of emergency, as defined in Section 6-1.3.

- All suitable habitats for populations of soft bird's-beak will be surveyed prior to all ground disturbing activities within the Pittsburg Power Plant HCP Area. If any populations are identified during the surveys, the USFWS and the CDFG will be notified prior to commencing maintenance or repair activities and these populations will be adequately fenced and protected during surface disturbing activities.

IMPLEMENTATION/PERMITS/OTHER MEASURES

The HCP will be implemented under the terms of the Section 10(a)(1)(B) permits issued by the USFWS and the NMFS, the Section 2080.1 approval process of the CDFG. Section 10(a)(2)(A)(iv) of the ESA requires that other measures be identified that are necessary and appropriate for purposes of the HCP. The USFWS, NMFS, and SE have agreed that the development and signing of a binding Implementation Agreement (IA) for each power plant for this HCP is appropriate. A Pittsburg Power Plant IA and a Contra Costa Power Plant IA have been prepared (Appendices G-1 and G-2 of the HCP) and reiterate the duties and responsibilities of the USFWS, NMFS, and SE).

The federal permits and state permit/management authorization will be issued to SE for a period of 15 years. As the permit holder, SE will be the primary entity responsible for administering the terms of the federal permits and state permit/management authorization and the Implementing Agreements.

APPLICABILITY OF THE SECTION 10(a)(1)(B) PERMIT AND STATE PERMIT/MANAGEMENT

Activities permitted shall include all activities associated with the operation, maintenance, and repair of the Pittsburg and Contra Costa Power Plants; fisheries monitoring activities at the power plants; and activities necessary to restore and enhance the Montezuma Enhancement Site. The primary activity that would result in the take of species addressed in the HCP is the take of sensitive fish species due to the intake of cooling water for condenser cooling.

MONITORING AND REPORTING

SE will annually report the results of monitoring, mitigation and habitat enhancement activities to the USFWS, NMFS, and CDFG. The monitoring will consist of, among other things, monitoring data for the AFB or if VSD used measuring cooling water flows on a 7-day running average basis from February 1 through July 31 at each power plant, and monitoring the effectiveness of the enhancement measures.

ALTERNATIVES

SE evaluated a range of alternatives to minimize take and the need for mitigation. The HCP offers the greatest practicable opportunity for successful implementation and affords suitable protection and recovery possibilities for sensitive species in the HCP Area. The proposed conservation program allows for the greatest flexibility for the Power Exchange and the Independent System Operator for bidding and dispatching to maintain system reliability, for a potentially greater flow reduction than with a simple flow reduction cap should VSD be implemented, and is consistent with the existing striped bass Resources Management Program (May 1-July 15 of each year).

Alternatives evaluated included:

- Alternative intake locations.
- Alternative intake structure designs and configurations.
- Improved maintenance of existing intake structures.
- Physical and behavioral barriers.
- Reduced cooling water flows.

- Habitat enhancement measures.
- No action.

This document is intended for planning purposes only. If any direct contradiction, conflict, or inconsistency exists between terms of SE's Pittsburg and Contra Costa Power Plant HCP and the associated Implementing Agreement, the terms of the Implementing Agreement shall control. In all other cases, the terms of the HCP and the terms of the Implementing Agreement shall be interpreted as supplementary to each other.

Section 1
INTRODUCTION

Southern Energy Delta, LLC (SE) owns and operates two fossil-fueled (natural gas) thermal power plants, Pittsburg and Contra Costa Power Plants, located on the southern shore of the Sacramento-San Joaquin Delta. Pittsburg and Contra Costa Power Plants were originally built and operated by Pacific Gas and Electric Company (PG&E) and were purchased by SE in April 1999. Consequently, many of the studies referenced in this document were either originally conducted by PG&E or were done by consultants specifically for them. The Pittsburg and Contra Costa Power Plants are located within an ecosystem that has changed dramatically during the past century. As a result of these changes, several native fish, wildlife, and plant species in the Delta have been adversely affected and federal and state agencies responsible for overseeing fish and wildlife resources have listed these Delta species as either being threatened or endangered with extinction. In view of these listings, SE has voluntarily chosen to implement several conservation measures intended to benefit the listed species. These conservation measures are formalized in this Habitat Conservation Plan (HCP). Without these changes, the continued operation of the Pittsburg and Contra Costa Power Plants could adversely affect the listed species. Further, if SE's operations were to adversely affect these listed species without appropriate authorization, SE could violate provisions of the federal and California Endangered Species Acts (ESA and CESA). Implementation of this Habitat Conservation Plan (HCP) is intended to meet the requirements of ESA and CESA to allow SE to operate the Pittsburg and Contra Costa Power Plants and to support the species recovery efforts of the various resource agencies. Implementation of the HCP will allow the issuance of Incidental Take Permits (ITP) for the power plants under the ESA and the necessary approvals under CESA.

1-1.0 DELTA BACKGROUND

Federal and state facilities development and operations for water supply, flood control, irrigation, and other purposes in the Central Valley have altered the timing and volume of flows entering the estuary and have adversely affected habitat for fish and wildlife in the Delta. During the past 140 years, the San Francisco Bay's open water area has been reduced by one-third, valuable wetland habitats have been greatly diminished, and more than one-half of the native upland habitats have been urbanized. These habitat changes have adversely affected the region's ability to support native fish and wildlife resources. In addition, the decline of phytoplankton and zooplankton abundance in the estuary's northern reach, the change in composition of the phytoplankton and zooplankton community, and the establishment of large numbers of the introduced clam *Potamocorbula amurensis* in Suisun Bay have further affected native fish and wildlife populations in the Delta.

Increased freshwater export from the Delta, increased numbers of screened and unscreened diversions, loss of shallow-water habitats, competition with non-native species, and exposure to toxic concentrations of agricultural, mining, and industrial chemicals have depleted populations of native fish and wildlife in the Delta. As a result, many of the Delta species populations, including the Delta smelt, Sacramento splittail, Sacramento River winter-run ESU chinook salmon (also referred to in this document as "winter-run"), Central Valley spring-run ESU chinook salmon (also referred to in this document as "spring-run"), Central Valley ESU steelhead (also referred to in this document as "steelhead"), California black rail, California clapper rail, California least tern, and salt marsh harvest mouse, have been adversely affected to the point where they have been listed as threatened or endangered under the ESA and CESA. The Central Valley fall/late fall-run ESU chinook salmon (also referred to in this document as "fall/late fall-run"), was considered for listing; however, the National Marine Fisheries Service (NMFS) determined that listing was not warranted and it remains a candidate species. The soft bird's-beak is proposed for threatened status.

1-2.0 REGULATORY BACKGROUND

The ESA, 15 USC Section 1531 et seq., establishes a process to list fish, wildlife and plant species as threatened or endangered and provides for the protection and conservation of those listed species. Administered by the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS), the ESA prohibits the "take" of any listed fish or wildlife species. Take, as defined by Section 9 of the ESA, means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Activities otherwise prohibited by the ESA, and subject to the civil and criminal enforcement provisions of Section 11 of the ESA, may be authorized for appropriate federal agency actions pursuant to Section 7 of the ESA and for non-federal agency or private actions pursuant to Section 10 of the ESA. As part of the requirements of Section 10, "incidental take" may be permitted with submittal of an HCP for the species affected by the non-federal agency or private action.

Similarly, CESA, California Fish and Game Code, Section 2050 et seq., provides for a process to list fish, wildlife and plant species as threatened or endangered and provides for the protection and conservation of those listed or candidate species. Administered by the California Department of Fish & Game (CDFG), Section 2080 prohibits the "take" of any listed species. Take, as defined by CESA, means to "hunt, pursue, catch, capture, or kill, or attempt to [engage in such activity]". Activities otherwise prohibited by Section 2080, and subject to the civil and criminal enforcement provisions of Section 12000 et seq., may be authorized for appropriate state agency actions pursuant to California Fish and Game Code Section 2090 et seq., and for other agency and private actions pursuant to Sections 2081 and 2084. Recent enabling legislation signed by the Governor on September 26, 1997, authorized the CDFG to issue Management Authorizations or permits under Section 2081 for authorization of incidental take for activities for which the primary purpose is not species conservation.

Pursuant to Section 10(a)(1)(B) of the ESA, the USFWS and NMFS may issue permits, under such terms and conditions as they may prescribe, for acts otherwise in violation of the ESA for the taking of any species incidental to an otherwise lawful activity. Section 10(a)(2)(A) requires incidental take permit applicants to submit a HCP that specifies, among other things, the impacts that are likely to result from the taking and the measures the applicant will, to the maximum extent practicable, undertake to minimize and mitigate such impacts. SE will attempt to obtain the appropriate state incidental take authorization as a part of this process.

The take prohibitions for federally listed plants under Section 9 of the ESA are more limited than for fish and wildlife. The ESA prohibits the removal of listed plants or the malicious damage of such plants on areas under federal jurisdiction, or the destruction of listed plants on non-federal areas in violation of state law or regulation. While there are no prohibitions under the ESA preventing private landowners from taking listed plants on their property, the HCP Guidelines issued by USFWS and NMFS recommends that incidental take permit applicants consider plants in HCPs. This is because all incidental take permit applications under Section 10 of the ESA ultimately require section 7 consultation, and the jeopardy standard under section 7 applies to plant as well as fish and wildlife species. Consequently, if a section 7 biological opinion concludes that issuance of an incidental take permit for wildlife species would jeopardize the existence of a listed plant species, the permit could not be issued. To avoid this outcome, an applicant must ensure that the mitigation program proposed in the HCP avoids jeopardizing any federally listed plant species found in the project area.

1-3.0 HCP BACKGROUND

This HCP was prepared in compliance with Section 10(a)(1)(B) and 10(a)(2)(A) of the ESA, USFWS and NMFS implementing regulations (50 CFR Parts 13, 17, and 222), and USFWS and NMFS's Habitat Conservation Planning Handbook (U.S. Department of Interior and National Oceanic and Atmospheric Administration, November 1996) (HCP Handbook). This HCP is also intended to meet the requirements of CESA and CDFG's Section 2081 Management Authorization Program. The HCP describes SE's activities regarding the continued operation of the Pittsburg and Contra Costa Power Plants and implementation of the mitigation plan at the Montezuma Enhancement Site that could result in incidental take, the impacts that are likely to result from the taking, and the measures SE will voluntarily undertake to minimize and mitigate such impacts. The HCP includes a phased plan for the mitigation, habitat enhancement and implementation of protective measures for Delta smelt, chinook salmon (winter-run, spring-run, and fall/late fall-run), steelhead, Sacramento splittail, green sturgeon, salt marsh harvest mouse, California black rail, California clapper rail, California least tern, and soft bird's-beak.

The term of the 10(a) permits and associated HCP/IA is for 15 years from the date of the issuance. It is the intent of this process to obtain separate take permits for the two facilities. Consequently, unless the information applies to both the Pittsburg and Contra Costa Power Plants, each power plant will be discussed separately in this document.

1-4.0 ELECTRIC UTILITY INDUSTRY RESTRUCTURING

In 1995, the California Public Utilities Commission (CPUC) issued its Preferred Policy Decision providing for the restructuring of the California electric industry. In 1996, restructuring legislation, Assembly Bill 1890 ("AB 1890"), was signed into law. AB 1890 created an Independent System Operator ("ISO") to operate the State's transmission system and a Power Exchange ("PX") to provide a day-ahead and hour-ahead market for electricity. Under AB 1890, as implemented by the CPUC, starting in early 1998, all California consumers are able to purchase electricity in a competitive generation market.

1-4.1 Management of the Transmission System: The ISO

The ISO will ensure system reliability and provide electric generators with open and comparable access to transmission and distribution services. California investor-owned utilities (IOUs) must commit control of their transmission facilities to the ISO. The ISO is required to ensure system reliability consistent with planning and operating reserve criteria no less stringent than those established by the Western Systems Coordinating Council and the North American Electric Reliability Council.

The ISO is charged with administering the California transmission grid in a safe, reliable and economically efficient manner. It will have operational control of the grid and all other related facilities required for the reliable and efficient operation of the grid and the right to control additional equipment to perform as control area operator.

The ISO is responsible for ensuring system reliability by (a) assuring adequate investment by the owners in transmission; (b) coordinating annual maintenance/outage schedules; (c) establishing transmission maintenance standards; (d) planning short-term operations; (e) scheduling operating reserves and other ancillary services, (f) dispatching generation and transmission, and (g) overriding the market in emergencies. The ISO will also assure necessary transmission system expansion.

As part of its mandate to ensure system reliability, the ISO must assess its need to call on generating units to support the transmission system. These generating units are considered "must-run" because they are necessary to maintain the transmission equipment loading within its normal ratings and acceptable voltage limits and to protect against emergency overloads and system instability/voltage collapse resulting from the loss of major transmission lines or generators. Because "must-run" units are needed for the reliability of the system, the ISO will have the right to call on them to operate under a "must-run" contract. Under the Must-Run Contract, the ISO will call upon a "must-run" unit to run when the ISO determines it is necessary for system reliability purposes.

The ISO has completed its initial determination of which units are "must-run." In making its determination, the ISO considered all generation sources within California, not just the investor-owned generating units. The ISO determined that both Pittsburg and Contra Costa Power Plants are "must-run" power plants.

1-4.2 The Wholesale Power Pool

The second element of the restructured industry is the establishment of a wholesale power pool called the Power Exchange (PX). The PX was implemented concurrent with the establishment of the ISO. The PX provides a market for electric power on a day ahead and a day of basis. The PX allows power producers to compete on common ground for bidding into the exchange. The PX then matches the generation bids with purchase requests submitted by utilities, power marketers, and brokers on behalf of end-use customers, ranking the least-cost bids according to protocols. The PX submits its delivery schedule to the ISO for integration with other schedules submitted under different arrangements. Participation in the PX is mandatory for the three IOUs of California. For the 4-year transition period ending December 31, 2001, the IOUs will be required to bid all of their generation into the PX and provide their need for electric energy on behalf of their full-service customers with purchases made from the exchange. A full description of both the ISO and the PX is provided in **Electric Restructuring in California: an Informational Report** (Greystone 1997).

1-5.0 THE PITTSBURG AND CONTRA COSTA POWER PLANTS

1-5.1 Historical and Future Need for the Pittsburg and Contra Costa Power Plants

SE's Pittsburg and Contra Costa Power Plants are located in the Sacramento-San Joaquin Delta at or a short distance downstream from the juncture of the San Joaquin and Sacramento rivers. Specifically, the Pittsburg and Contra Costa Power Plants are located approximately 48(78[illegible]) and 56(90km) miles, respectively, upstream from the Golden Gate Bridge. Because of their location, the Pittsburg and Contra Costa Power Plants play an important role in electricity generation and voltage support within the San Francisco Bay Area (Bay Area). Historically, power generation for the Bay Area has varied depending on the availability of hydroelectric generation resources. In wet years, when hydroelectric generation is plentiful, generation demands from fossil-fueled power plants, such as the Pittsburg and Contra Costa Power Plants, may be reduced. However, during dry years, fossil-fueled power plants must be operated to a greater extent to meet demand; in these years, the Pittsburg and Contra Costa Power Plants are considered a necessity to provide electricity generation and voltage support for the Bay Area. The actual generation needed from the Pittsburg and Contra Costa Power Plants depends on a number of factors, including weather conditions, availability of other local generation resources, availability of imported power, transmission line constraints, voltage support requirements, and needs of other entities within the western power grid.

Although the Bay Area is served by a combination of local generation and power imported into the area over several transmission lines, 100% of the Bay Area load cannot be served by imported power; the Bay Area transmission system is simply not capable of carrying that much electricity. Local generation in the Bay Area is also required to meet power quality criteria. Therefore, safe and reliable operation of the present Bay Area transmission system requires a minimum amount of in-area "must-run" generation. Pittsburg and Contra Costa Power Plants are critical participants in fulfilling this generation need. Electrical generation from these facilities is needed most in the summer, typically June-September, when Bay Area loads are the highest. A more thorough explanation of "must-run" generation and the Bay Area constraint is provided in Appendix B of Pacific Gas and Electric Company's (PG&E's) July 19, 1996 "Market Power" filing before the Federal Energy Regulatory Commission (Docket No. ER96-1663-000).

The Bay Area daily peak load typically varies between 5,000 MW and 7,900 MW. The import capability to the Bay Area is approximately 4,500-5,300 MW, depending on system conditions. Certain critical single transmission or generation contingencies may result in transmission system overloads, low area voltages, and/or possible voltage collapse. Thus, a minimum amount of generation is required for safe, reliable operation of the Bay Area transmission system.

The quality and duration of generation from Pittsburg and Contra Costa Power Plants is expected to increase to meet the demands of an increasing Bay Area population. Between 1980 and 1994, California's population increased from 23.5 million to 32.1 million (about 27%). California's population is expected to increase to 43 million by the year 2011, an additional increase of about 25% (Greystone 1997). Bay Area load is predicted to grow at 100-150 MW per year to meet these additional needs.

The CPUC's mandated changes in the public utility regulatory arena has changed the way the power generation is operated in California and the way the Pittsburg and Contra Costa Power Plants are operated. This condition requires power generation facilities to produce competitively priced electric power for sale to individual parties, to utility distribution companies or to the PX. This competitive environment may determine the actual operational requirements (i.e., circulating water flows) of the Pittsburg and Contra Costa Power Plants. The ability to compete with other generation facilities will determine the economic viability of the Pittsburg and Contra Costa Power Plants. The ability to operate the plants within the range of design capacity as outlined in this

HCP could determine whether the Pittsburg and Contra Costa Power Plants can be operated in this competitive environment.

1-5.2 Operation of the Pittsburg and Contra Costa Power Plants

The steam electric generation facilities of the Pittsburg and Contra Costa Power Plants were constructed to utilize large volumes of water for condenser cooling as part of the process of generating electricity. The Pittsburg and Contra Costa Power Plants use the combustion of natural gas to produce steam in a boiler. Steam heated to a very high temperature builds pressure, and when this super heated steam is released into a steam turbine, the blades spin and drive mechanical electricity generators. The Pittsburg and Contra Costa Power Plants non-consumptively use the Delta waters to cool the steam coming from the steam turbines and the condensed steam is returned to the boiler.

1-5.3 General Effects on Aquatic Species

Operation of the Pittsburg and Contra Costa Power Plants has the potential of affecting aquatic species through entrainment, impingement, and exposure to elevated water temperatures. Entrainment is the hydraulic capture and subsequent passage of organisms through the cooling water system. The organisms involved are small (typically less than 38 mm in length), capable of passing through the 3/8-inch (9.5-mm) mesh of the power plant intake screens, and include the eggs, larvae, and early juvenile stages of various fish species. As these entrained organisms pass through the circulating-water system, they can be exposed to mechanical, pressure, shear, thermal, and chemical stresses.

Larger organisms that are unable to pass through the 3/8-inch mesh intake screens may become impinged. Impingement occurs when an organism is held against the intake screens used to remove debris from the circulating water. Fish susceptible to impingement are typically either small juveniles (typically greater than 38 mm long) or large juveniles and adults that are in a weakened condition or have died from other causes. The survival of impinged fish depends on the species, life stage, and size of the organism, and the duration of impingement.

Potential effects associated with exposure to the Pittsburg and Contra Costa Power Plants thermal discharge plum include behavioral avoidance, behavioral attraction, migration blockage, increased susceptibility to predation, sub-lethal stresses resulting in reduced health and fitness, and potential acute mortality resulting from elevated temperatures. Studies on the thermal plume beyond the Pittsburg and Contra Costa Power Plants discharge have shown that the plume is primarily a surface phenomenon and that no mortality is expected from plume exposure (PG&E 1992). Thermal effects studies indicate that some species may be attracted to the discharge plume under certain conditions, but there is no evidence of adverse effects.

1-5.4 General Effects on Terrestrial Species

The Pittsburg and Contra Costa Power Plant operation, maintenance, and repair activities have the potential to impact various terrestrial species of plants and wildlife. These impacts typically result from ground surface disturbance activities.

PITTSBURG POWER PLANT

SE's Pittsburg Power Plant, a 2,060-megawatt (MW) steam generation facility, is located on the south shore of Suisun Bay, just west of Pittsburg. The power plant consists of seven units. With the exception of Unit 7, each unit uses a once-through cooling water system. Pittsburg Unit 7 employs mechanical-draft cooling towers with makeup water supplied from the river. The largest unit is Unit 7, a 720-MW unit. This unit, together with the 330- to 340-MW class units (Units 5 and 6), are the most efficient units and are committed most frequently to meet system demands. Units 1-4 are 170-MW class units; these units are significantly less efficient than the larger units and are operated less frequently, but are still needed to maintain local area reliability and voltage support.

CONTRA COSTA POWER PLANT

SE's Contra Costa Power Plant, a 680 MW steam generation facility (formerly 1,260-MW), is located on the south shore of the San Joaquin River, east of Antioch. The power plant currently consists of two operational generating units (formerly seven units). The 330- to 340-MW class units (Units 6 and 7) are the most efficient units and are committed most frequently to meet system demands. Units 4 and 5 are 120-MW class units. They are currently operated as synchronous condensers that provide power quality support rather than power generation. Units 1-3 are 110-MW class units that have been retired.

SE is currently planning to construct a new Unit 8 at this facility, anticipated to produce 530 MW. SE anticipates that this unit will come online in 2003. Unit 8 will use a closed-cycle mechanical draft cooling tower utilizing make-up water from the discharge of Units 6 and 7.

Section 2
BIOLOGICAL ISSUES

2-1.0 INTRODUCTION

Under Section 10(a)(2)(A)(i) of the ESA and the ESA implementing regulations (50 CFR §§ 17.22(b)(1), 17.32(b)(1), and 222.22), an HCP submitted in support of an application for an incidental take permit must detail "the impact that will likely result from such taking." As part of the analysis of the impacts of the incidental taking, the USFWS and NMFS HCP Handbook states that a "collection and synthesis of biological data for species covered by the HCP" should be presented in the HCP. Prior to the presentation of the impacts likely to result from the Pittsburg and Contra Costa Power Plants and related actions, this section reviews the biological issues and the environmental setting related to the Delta and specifically to the Pittsburg Power Plant and Contra Costa Power Plant.

2-2.0 EXTERNAL FACTORS AFFECTING THE BAY-DELTA

The San Francisco Bay/Sacramento-San Joaquin Delta (Bay Delta) estuary is the largest estuary on the west coasts of North and South America. It comprises two regions, the San Francisco Bay and the Sacramento-San Joaquin Delta (Delta). The San Francisco Bay system is the largest coastal embayment on the Pacific Coast of the United States (Nichols and Pamatmat 1988). It consists of Suisun Bay, Carquinez Strait, San Pablo Bay, and San Francisco Bay. Suisun Bay is a shallow embayment between Chipps Island at the western boundary of the Delta and the Benicia-Martinez Bridge. Adjacent is Suisun Marsh, the largest brackish marsh in the United States (Monroe et al. 1992).

The estuary bears little resemblance to its past. Before 1848, human impacts on the estuary's water quality and its ability to sustain biological resources were minimal. Hydraulic gold mining caused the first major human alteration of the estuary. By the early 1900s, more than 1 billion cubic yards of mining debris had silted-in hundreds of miles of streams and raised the bottom of parts of San Francisco Ba[illegible] much as 3 ft. By the [illegible] of the century, levee construction in the Delta and along the bayshore enabled the conversion of more than half of the estuary's tidal wetlands to farmlands and other uses. Conversion of the shoreline wetlands to urban uses has continued, although at a slower rate during the past few decades. Water development for flood control, irrigation, and other purposes in the Central Valley has altered the timing and volume of flows entering the estuary and has adversely affected fish and wildlife habitat.

The human population in the 12 estuary counties has increased from about 1 million in 1920 to more than 7.5 million today, making the San Francisco Bay Area the fourth most populous metropolitan area in the United States. Urban expansion has converted thousands of acres of farms, rangeland, and forests to towns and cities. This has increased the estuary's pollutant loads and has lowered the region's ability to support fish and wildlife.

Tides influence the estuary's plants and animals by moving and mixing large masses of water. Tidal action raises and lowers the water level on intertidal mudflats and in the marshes along the shoreline, exposing and flooding these areas twice daily. This washes decaying plant material out of the marshes and also helps disperse the young life forms of many plants and animals. Tides also affect conditions for aquatic organisms in the estuary as they alternately accelerate or slow the seaward motion of freshwater. The estuary has two low tides and two high tides every 24.8 hours. During each tidal cycle, an average of about 1.3 million acre-feet of water, or 24% of San Francisco Bay's volume, moves in and out of the estuary (Conomos 1979). On the flood tide, ocean water moves through the Golden Gate and into the estuary's southern and northern reaches, raising the water level at the end of the South Bay by more than 8 ft, and raising the height of the Sacramento River at the upstream edge of the estuary by about 3 ft. The salinity of the estuary's northern reach varies considerably and increases along a gradient from the Delta to the central bay. Mean annual salinity is slightly less than 2 parts per thousand (ppt) at the mouth of the Sacramento River; about 7 ppt in Suisun Bay; and about 30 ppt at the Presidio in San Francisco Bay.

Federal and state facilities development and operations for water supply, flood control, irrigation, and other purposes in the Central Valley have altered the timing and volume of flows entering the estuary and have adversely affected fish and wildlife habitat in the Delta. Water sent from northern California to central and southern California or to the Bay Area by the State Water Project (SWP), operated by the California Department of Water Resources (DWR), and the Central Valley Project (CVP), operated by the U.S. Bureau of Reclamation (Reclamation), must pass through the Delta. Water is diverted from the Delta by the CVP and the SWP; agricultural users of water from approximately 1,800 local irrigation diversions; and cities such as Antioch and Concord to supply the domestic needs of two-thirds of the state's population and irrigate several million acres of farmlands.

Between 1985 and 2005, about 400 square miles of land in the estuary will be converted to urban uses. This and additional losses of wetlands will further compromise the region's ability to support a thriving community of fish and wildlife.

Wetlands and shallow water areas are among the estuary's most valuable habitats. Most of the estuary's wetlands occur in South Bay, San Pablo Bay, Suisun Bay, and the Delta. In South Bay, intertidal mudflats, salt ponds, and seasonal wetlands predominate. In San Pablo Bay, intertidal mudflats and farmed wetlands are the most abundant. Most Delta wetlands are seasonal farmed wetlands. Suisun Bay is dominated by diked salt and brackish water marshes.

Tidal marshes contribute to the productivity of other intertidal and subtidal habitats by releasing detritus (dead plant and animal material), which is consumed by benthic grazers. During droughts, the tidal marshes of San Francisco Bay take on added importance because they provide habitat critical to migratory and resident waterfowl. More than 80% of the historic tidal marshes around the bay have been filled or converted to other wetland uses; high marshes have been the most severely affected.

The estuary is one of the most important staging and wintering areas for migratory waterfowl and shorebird populations on the west coasts of North and South America. Nearly 1 million waterfowl and 1 million shorebirds use the estuary's open water and wetland habitats. As waterfowl habitat has dwindled in other parts of the state, the estuary has become increasingly important for maintaining bird populations.

During the past 140 years, many of the habitats in the estuary have been converted or degraded. The areal extent of San Francisco Bay's open water has been reduced by one-third, valuable wetland habitats have been greatly diminished, and more than one-half of the native upland habitats have been urbanized. These habitat changes have adversely affected the region's ability to support native fish and wildlife resources.

The health of populations of estuarine species is closely linked to the condition of the estuarine environment. The recurrence of drought (both in 1976-1977 and 1987-1992), combined with increasing human demands on water supply, have shown that fish populations and wetland habitats are sensitive to system changes. Among the many factors affecting the estuarine environment are the rate and timing of freshwater inflow to the estuary; the quantities of fresh water reaching it seasonally, annually, and over a series of years; and diversions from the estuary for both local and export uses. In the past 50 years, developments in the vicinity of the Bay-Delta estuary, along with numerous local, state, and federal water developments on Central Valley tributary streams, caused changes in the timing and amounts of Delta inflows and outflows during most years.

2-3.0 FUTURE ACTIONS AFFECTING THE BAY-DELTA

Future conditions for aquatic species in the Bay and Delta may be directly determined by the on-going CALFED process to "fix" the Delta, which is an out-growth of the December 1994 Principles of Agreement between the federal and state governments, water user groups, and environmental interest groups. The Agreement, if it is adhered to, will become a major factor in determining the seasonal distribution and abundance of some of the aquatic species near the Delta Power Plants, particularly Delta smelt, longfin smelt, chinook salmon, steelhead, and Sacramento splittail. The Agreement establishes standards for salinity in the estuary. Specifically, the standards determine the degree to which salinity is allowed to penetrate up-estuary, with salinity to be controlled through Delta outflow. The basis for the standards is a series of relationships between the salinity pattern and the abundance or survival of various species of fish and invertebrates. These relationships have been expressed in terms of "X2," the distance from the Golden Gate to the upstream point where daily average salinity is 2 ppt measured 1 meter off the bottom. Generally, the higher the outflow, the lower the value of X2, and the higher the abundance or survival of species of interest.

The Interagency Ecological Program (IEP) Estuarine Ecology Team analyzed the mechanisms most likely to be responsible for the observed relationships of fish abundance or survival to X2 in a draft report **An Assessment of the Likely Mechanisms Underlying the "Fish-X2" Relationships** (IEP 1996). That analysis indicated the following with regards to the effects of the operation of the Delta Power Plants on the target fish species included in this HCP:

- In low outflow years, Delta smelt may exhibit higher probability of entrainment mortality at the Delta Power Plants than in high outflow years; however, the overall effects of X2 on entrainment losses is not well documented and the consequences of this mortality for the populations dynamics of Delta smelt are unclear, but potentially important.

- In low outflow years, Sacramento splittail may have a greater percentage of the population shifted upstream near the intakes of the Delta Power Plants; however, the limited studies performed to date indicate that entrainment is not exceptionally high.

- In low outflow years, longfin smelt may experience increased entrainment losses at the Delta Power Plants as larvae are not transported as far downstream and the brackish water nursery moves from San Pablo and Suisun bays to the Delta.

- In higher outflow years (and a downstream location of X2), chinook salmon and steelhead experience an increase in the speed at which out migrating smolts are able to move downstream. This reduces their exposure to the influence of the Delta Power Plants.

The primary element of the Agreement establishes the seasonal positioning of X2 within the Delta by adjusting the amounts of freshwater diverted by the export pumps for the Central Valley Project and the State Water Project. How this positioning of the X2 zone will be decided in the future will likely be determined by the CALFED process. The CALFED process is considering various in-Delta alternatives that may include new channel construction, channel widening, and/or construction of an isolated pipeline or canal that will move high quality Sacramento River water to the export pumps.

In the negotiations leading to the Delta Agreement, the water user community concluded that a comprehensive program of Bay-Delta protections must include, in addition to the flow and operational components of the Agreement, measures to address non-flow-related factors that have contributed to the historical decline of the Bay-Delta ecological resources. These factors, termed Category III, include:

- Unscreened water diversions;
- Pollution from municipal, industrial, and agricultural discharges;
- Overfishing and illegal fishing;
- Pollution (poor water quality);
- Degradation of habitat due to levees and channelization;
- Degradation of wetlands and other critical terrestrial habitat;
- Proliferation of harmful non-native species; and
- Fish passage barriers.

2-4.0 SPECIES ADDRESSED IN THE PITTSBURG AND CONTRA COSTA POWER PLANTS HCP

The aquatic and terrestrial species addressed in this plan (Table 2-1) include listed (federal and state endangered and threatened), proposed, and other sensitive species that might occur within the HCP boundary, and may be affected by SE's maintenance, repair, operation, enhancement, and monitoring activities identified in Section 3. The potential or known occurrence of each of these sensitive species located at each site is shown in the table. The species which need to be included in the permit for the Pittsburg Power Plant will include those species indicated under the Pittsburg and Montezuma columns and for the Contra Costa Power Plant will include those species indicated under the Contra Costa and Montezuma columns.

Table 2-1. Species Included in the Pittsburg and Contra Costa Power Plants HCP

COMMON NAME	Scientific name	State Status [1]	Federal status [1]	Known or potential occurrence		
				Pittsburg	Contra Costa	Montezuma
Delta smelt [2]	*Hypomesus transpacificus*	T	T	X	X	X
Longfin smelt	*Spirinchus thaleichthys*	None	None	X	X	X
Sacramento River winter-run ESU chinook salmon[2]	*Oncorhynchus tshawytscha*	E	E	X	X	X
Central Valley spring-run ESU chinook salmon	*Oncorhynchus tshawytscha*	T	T	X	X	X
Central Valley fall/late fall-run ESU chinook salmon	*Oncorhynchus tshawytscha*	None	C	X	X	X
Central Valley ESU steelhead	*Oncorhynchus mykiss*	None	T	X	X	X
Sacramento splittail	*Pogonichthys macrolepidotus*	None	T	X	X	X
Green sturgeon	*Acipenser medirostris*	None	None	X	X	X
California black rail	*Laterallus jamaicensis coturniculus*	T	None	X		X
California clapper rail	*Rallus longirostris obsoletus*	E	E	X		
California least tern	*Sterna antillarum browni*	E	E	X		
Salt marsh harvest mouse	*Reithrodontomys raviventris*	E	E	X		X
Soft bird's-beak	*Cordylanthus mollis* ssp. *mollis*	Rare	PE	X		

[1] **STATUS:**
E = Endangered; **T** = Threatened; **PT** = Proposed Threatened; **PE** = Proposed Endangered; **C** = Candidate.

[2] Critical habitat has been designated for Delta smelt in the Pittsburg and Contra Costa Power Plants and the Montezuma Enhancement Site HCP areas. Critical habitat has been designated for winter-run salmon in the Pittsburg Power Plant and Montezuma Enhancement Site HCP areas. Critical habitat has not been designated at this time for any of the other species listed in this document.

Existing biological information about species distribution, occurrence, and ecological requirements for all of the addressed sensitive species is presented in Appendix A. Most of the information for the fish species was taken from the **Sacramento-San Joaquin Delta Native Fishes Recovery Plan** (USFWS 1996). The information for the Sacramento River winter-run ESU chinook salmon profile was taken from the **1995 Working Paper on Restoration Needs for Central Valley Anadromous Fish** prepared for the USFWS and the **1993 Action Plan for Restoring Central Valley Streams** produced by CDFG. For the Central Valley ESU steelhead, the **Steelhead Restoration and Management Plan for California** (CDFG 1996) was the primary source. Information for the rest of the species was compiled from numerous existing sources.

PITTSBURG POWER PLANT

2-5.0 DELTA HYDROLOGY AND WATER QUALITY IN THE VICINITY OF THE PITTSBURG POWER PLANT

In the western Delta, the main channels of the Sacramento and San Joaquin rivers join and form a single channel that enters Suisun Bay at Chipps Island. Suisun Bay, extending from Chipps Island in the east to the Benicia Bridge in the west, is the smallest of the major bays of the San Francisco Bay/Delta estuary. Except for a shipping channel along its south shore, Suisun Bay is extremely shallow. Over one-third of Suisun Bay is less than 6 ft deep at mean lower low water (MLLW). North of the shipping channel lie Honker Bay and Grizzly Bay, two shallow extensions of Suisun Bay. The southern shore of Suisun Bay, which includes the city of Pittsburg, is partly urbanized and industrialized. Industries include chemical manufacturing plants and the Pittsburg Power Plant. The northern shore is less developed, consisting largely of an extensively managed wetland area, Suisun Marsh.

The hydrology of Suisun Bay and the western Delta is important to the San Francisco Bay estuarine ecosystem. The aquatic environment near the Pittsburg Power Plant fluctuates between a typically freshwater environment in periods of high freshwater inflow and a brackish-water environment when freshwater outflow is low. Seasonal changes in water temperature and salinity affect species composition and abundance of the aquatic community in the area. Water quality in the vicinity of the plant, as in the Delta in general, is influenced primarily by freshwater inflow and tidal circulation. Tidal flow entering the Delta from Suisun Bay influences both the Sacramento and San Joaquin river systems. Tides are semidiurnal, with two flood and two ebb phases per 24.8-hour tidal day. Mean tidal range at Pittsburg is about 3.3 ft. The average tidal flow in front of the plant is approximately 170,000 cfs (4,800 m^3/s) (PG&E 1970). The effective volume of water that moves back and forth past the area depends on tidal conditions and freshwater inflow, and has been assumed to be equal to the tidal prism, i.e., the quantity of water passing the power plants between successive tidal phases minus the Delta outflow, calculated as approximately 1.3 billion ft^3 (37 million m^3) (Tetra Tech 1976). Tidal currents within the Delta reverse direction between flood and ebb tide cycles, which has a substantial effect on the size and location of the thermal discharge plume of the power plant.

Hydraulic characteristics of the mixing zone between freshwater flowing into the Delta from the Sacramento and San Joaquin river systems and saltwater intrusion from San Francisco Bay is characterized by a zone of particle accumulation frequently referred to as the "null zone." Data from Arthur and Ball (1978, 1979) and Kimmerer (1991) have shown that the location of the null zone can be defined by surface salinities ranging from approximately 1 to 6 ppt. These studies have also shown that the location of the null zone, as defined by salinity conditions, varies in response to changes in freshwater inflow. During periods when freshwater inflow is greater (e.g., 7,500-15,000 cfs), the null zone is located downstream within Suisun Bay in the general vicinity of the Pittsburg Power Plant. The magnitude of freshwater inflow during late winter and spring influences the location of the null zone and the geographic distribution of larval Delta smelt (*Hypomesus transpacificus*) and other species of concern, thereby affecting their susceptibility and exposure to the circulating water systems at the power plants.

2-6.0 AQUATIC HABITATS AND SPECIES IN THE VICINITY OF THE PITTSBURG POWER PLANT

Source waters for the Pittsburg Power Plant circulating water system are characteristic of the estuary that separates the upstream, freshwater Delta from the downstream, saltwater bays. The areas adjacent to the plants contain several types of aquatic habitats, including freshwater and brackish marshes, shallow channel and shoal areas, and the main river channel. Together, these habitats support a diverse aquatic community.

The area east of the Pittsburg Power Plant consists of brackish and freshwater marshes. The area between the shore and the deepwater channel is characterized by water depths of less than 20 ft, a mud, mud-sand, or peat-detritus bottom, and reduced exposure to tidal and river currents. The inshore areas of the shoals are bordered by emergent vegetation. Small crustaceans, particularly mysid shrimp (*Neomysis mercedis*) and amphipods of the genus *Corophium*, inhabit the area and are important food items for young-of-the-year fish. Fish species occurring in the shallow channel and shoal areas adjacent to the power plant include striped bass (*Morone saxatilis*), chinook salmon (*Oncorhynchus* tshawytscha), longfin smelt (*Spirinchus thaleichthys*), Delta smelt, wakasagi (*H. nipponensis*), threespine stickleback (*Gasterosteus aculeatus*), tule perch (*Hysterocarpus traski*), Sacramento squawfish (*Ptychocheilus grandis*), gobies (*Acanthogobius flavimanus, Tridentiger bifasciatus*), inland silverside (*Menidia beryllina*), starry flounder (*Platichthys stellatus*), Sacramento splittail (*Pogonichthys macrolepidotus*), carp (*Cyprinus carpio*), largemouth bass (*Micropterus salmoides*), and catfish (*Ictalurus* sp.).

River and shipping channels are characterized by depths of more than 20 ft and by strong tidal and river currents (1.1-1.5 fps). Dredged shipping channels are present adjacent to the Pittsburg Power Plant. The river bottom generally comprises fine silts and sand. Invertebrates that inhabit this area include bottom-dwelling polychaetes, amphipods, and bivalves, and epibenthic shrimp, primarily *Neomysis mercedis*, *Palaemon macrodactylus*, and *Crangon* spp. The open waters of the lower Sacramento and San Joaquin rivers and Suisun Bay serve as a migratory route for several species of anadromous fish that migrate to the freshwater reaches of the tributary rivers to spawn. These fishes include striped bass, steelhead (*O. mykiss*), chinook salmon, white and green sturgeon (*Acipenser transmontanus* and *A. medirostris*), and American shad (*Alosa sapidissima*). Many other marine, estuarine, and freshwater fish, including Sacramento squawfish, catfish, longfin and Delta smelt, carp, and splittail, occur in these areas.

Threats to the Delta aquatic ecosystem include loss of habitat due to decreased freshwater inflows that have increased salinity; loss of shallow-water habitat due to dredging, diking, and filling; pollution; introduced aquatic species that have disrupted the food chain; entrainment; and altered patterns and timing of flows through the Delta resulting from state, federal and private water diversions. These threats have resulted in the development of the **Sacramento-San Joaquin Delta Native Fishes Recovery Plan** (USFWS 1996) for seven fish species in the Delta. The seven species, Delta smelt, Sacramento splittail, longfin smelt, green sturgeon, Sacramento perch, and spring-run and fall/late fall-run chinook salmon, depend on the Sacramento-San Joaquin Delta for a significant segment of their life history. The recovery plan identifies the following actions needed for recovery for these species.

1. Enhancing and restoring aquatic and wetland habitat in the Sacramento-San Joaquin Delta.
2. Reducing effects of commercial and recreational harvest.
3. Reducing effects of introduced aquatic species on native Delta fishes.
4. Changing and improving enforcement of regulatory mechanisms.
5. Conducting monitoring and research on fish biology and management requirements.
6. Assessing recovery management actions and reassessing prioritization of actions.
7. Increasing public awareness of the importance of native Delta fishes.

Winter-run chinook salmon and steelhead, two other HCP-listed fish species that utilize the Delta, are not included in the Delta Fishes Recovery Plan, but are addressed in the **Recommendations for the Recovery of the Sacramento River Winter-run Chinook Salmon** (NMFS 1996) and the **Steelhead Restoration and Management Plan for California** (CDFG 1996), respectively.

Natural Delta inflow consists of rain runoff during late fall and winter and snowmelt in spring and summer. The major rivers that drain into the Delta are dammed for flood control, water storage, and hydroelectric power generation. The current Delta system is a highly controlled and modified environment. The estuary serves as a water source for local agriculture, industries and municipalities, and state and federal water diversion facilities. The principal mechanism for control of water entering the Delta is through a pair of independent, yet coordinated and cooperative water systems: the Central Valley Project (CVP) operated by the U.S. Bureau of

Reclamation, and the California State Water Project (SWP) operated by the Department of Water Resources (DWR). The balance between diversion of freshwater from the Delta and water storage and release from the reservoirs plays a critical part in the regulation and control of physical, chemical, and biological processes in the estuary. The release of stored water during the summer and fall dry seasons has considerably altered the freshwater flow and salinity regimes in the Delta. At the same time, diversions from the estuary of freshwater inflow have altered the total freshwater input to the San Francisco Bay/Delta and the patterns of flow and salinity. Freshwater flow patterns are important to the physical, chemical, and biological processes of the Bay/Delta system. Seasonal reductions in Delta inflow, as a consequence of upstream storage within impoundments and increased diversions and consumptive use, have been identified as major factors affecting the abundance of a variety of Delta fish and macroinvertebrates.

Increased diversions, especially in dry years, results in a reduction in both total outflow and high spring outflows. These reductions can affect salinity, the location of the mixing zone, river flow direction, primary productivity, and survival of larval and juvenile fish. During periods of drought and increased water diversions, the mixing zone is shifted further upstream in the Delta. Since 1984, with the exception of record flood flows of 1986, the mixing zone has been located primarily in the river channels during the entire year because of increased water exports and diversions (Fed. Reg. Vol. 58, No. 42, March 5, 1993, Final Rule on Delta smelt). When located upstream, the mixing zone becomes confined to the deep river channels, becomes smaller in total surface area, contains very few shallow areas suitable for spawning, may have swifter, more turbulent water currents, and lacks the high zooplankton productivity that is present in the shallow waters of Suisun Bay. In all respects, the upper river channels provide much less favorable spawning and rearing habitat for Delta smelt than that provided when the mixing zone occurs further down where it occupies a large geographic area and includes extensive shallow areas that provide suitable spawning substrates within the euphotic zone (depths less than 4 m).

Channelization and dredging of Delta waterways in combination with levee construction and reclamation have contributed to changes in water velocities, residence time, hydrologic patterns, and the areal extent of shallow water, shoals, and marsh habitats. The availability of shallow water and marsh habitats within the Delta, which historically provided habitat for a variety of species, has been reduced substantially through reclamation of Delta islands for agricultural use and the filling and diking of areas for industrial and residential use. These changes to the Delta environment have resulted in significant modifications and reductions in habitat availability and suitability for aquatic species.

Data on the status of various aquatic organisms inhabiting the estuary system show a number of changes in species composition and relative abundance of fish and macroinvertebrate populations (Moyle and Herbold 1989, Herbold et al. 1992, CDFG 1993). Results from these studies have demonstrated the introduction and rapid increase in abundance of fish species such as yellowfin goby and invertebrates including the copepods *Pseudodiaptomous forbesi* and *Sinocalanus doerri* and the clam *Potamocorbula amurensis* during the past decade. Abundances of the copepods *Eurytemora affinis* and *Diaptomus* spp., mysid shrimp, and shrimp (*Palaemon macrodactylus* and *Crangon franciscorum*) have declined in recent years (Herbold et al. 1992).

Federal and state water diversion projects export, by absolute volume, mostly Sacramento River water with some San Joaquin River water. During periods of high export pumping and low to moderate river outflows, however, portions of the San Joaquin River and other channels reverse direction (i.e., negative or positive upstream flow) and flow toward the pumping plants located in the southern Delta. In recent years, the number of days of reversed flow have increased, particularly during the February-June spawning months for Delta smelt (Moyle et al. 1992). During periods of negative flow, out-migrating larval and juvenile fish of many species become disorientated. Net positive riverine flows and estuarine outflows of sufficient magnitude are required for larval and juvenile fish to be carried downstream and into the upper end of the mixing zone of the estuary rather than upstream to the pumping plants. Large mortalities occur as a result of entrainment and predation by striped bass at the various water pumping and diversion facilities. All size classes of Delta smelt suffer near total loss when they are entrained by the pumping plants and water diversions located in the south Delta (Fed. Reg. Vol. 58, No. 42, March 5, 1993, Final Rule on Delta smelt). Very few smelt are effectively salvaged at the federal and State pumping plant screens, and it is unlikely that many Delta smelt survive the handling (Fed. Reg. Vol. 58, No. 42, March 5, 1993, Final Rule on Delta smelt and USFWS 1995).

Although precise estimates of the numbers of native Delta fish species lost as a consequence of entrainment at water diversions within the Delta are not available, DWR has developed estimates of losses for some species at state and federal water project diversions. Estimated entrainment losses of larval Delta smelt less than 21 mm long at the CVP and SWP were 1.2 million in 1992 (DWR 1993). Estimates of the number of juvenile and adult Delta smelt (21 mm and greater) salvaged at the SWP varies throughout the year, with an average monthly estimate of up to 8,000 fish during June (DWR 1993). Expanded salvage estimates of Delta smelt at the SWP between 1976 and 1992 have shown monthly salvage estimates as high as 255,000 Delta smelt in 1976, although the variability in salvage is substantial between months and between years. Additional losses of native Delta fishes occurs as a result of the operation of the Central Valley Project. In addition, there are an estimated 1,800 screened and unscreened agricultural, industrial, and municipal diversions in the Delta. Operation of these diversions results in direct entrainment losses for native Delta fishes and the phytoplankton and zooplankton that provide the food resources for many of these fishes.

2-6.1 Sensitive Aquatic Species in the Vicinity of the Pittsburg Power Plant

The following sensitive aquatic species occur in the vicinity of and could potentially be affected by the operation, repair and maintenance of the Pittsburg Power Plant.

- The Delta smelt is a pelagic member of the smelt family (Osmeridae) that is endemic to the Sacramento/San Joaquin Delta. It is currently listed as threatened by the USFWS and the CDFG.

- The longfin smelt is a euryhaline/anadromous member of the smelt (Osmeridae) family that occurs along the west coast of North America. It currently has no official state or federal status.

- The Sacramento splittail is a benthic foraging member of the minnow (Cyprinidae) family that is endemic to the Sacramento/San Joaquin Delta. It is listed as threatened by the USFWS.

- The chinook salmon is an anadromous member of the salmon and trout family (Salmonidae) that occurs along the west coast of North America, as well as Japan and Russia. Three races of chinook salmon are of concern in California: the winter-run, fall/late fall-run, and spring-run. The winter-run is listed as endangered by the NMFS, and the spring-run is listed as threatened by NMFS and CDFG. The fall/late fall-run was proposed for listing as threatened in March 1998; however, NMFS determined that listing of this ESU was not warranted and the Central Valley fall/late fall run ESU remains a candidate species. (64 Fed. Reg. 50,394 (Sept. 16, 1999)).

- The steelhead is an anadromous member of the Salmon and trout family (Salmonidae) that is endemic to the west coast of North America. The steelhead utilizing the Central Valley river systems are primarily of the winter-run variety. Central Valley steelhead were listed as threatened by NMFS in March 1998.

- The green sturgeon is an anadromous member of the sturgeon family (Acipenseridae) that occurs along the west coast of North America, as well as Japan and Russia. It currently has no official state or federal status.

These species are described in detail in Appendix A.

2-7.0 TERRESTRIAL HABITATS AND SPECIES IN THE VICINITY OF THE PITTSBURG POWER PLANT

Major factors threatening plant and wildlife species in the estuary are habitat loss and degradation, disease, introduced predators and competitors, and pollution. Two-thirds of the 89 species of resident wildlife currently in decline or receiving special attention from the state or federal governments are dependent on wetlands. The natural communities that comprise tidal wetlands, freshwater wetlands, and native uplands, as well as the plant, fish, and wildlife species that depend on those communities, have been significantly reduced in the Delta.

Almost all the land in the central, northern, eastern, and southern Delta is committed to agriculture; the western Delta adjacent to the Pittsburg Power Plant is largely urbanized and industrialized. The southern shore of Suisun Bay, which includes the city of Pittsburg, is partly urbanized and industrialized. Industries include chemical manufacturing and the Pittsburg Power Plant.

About 44% of the 1,199-acre Pittsburg Power Plant site is dedicated to utility facilities and operations. The remainder of the site, about 674 acres, consists of relatively undisturbed areas of freshwater marsh, brackish marsh, and grassland communities.

The tidal wetlands that occur in the vicinity of the Pittsburg Power Plant include coastal brackish marsh and coastal/valley freshwater marsh. Coastal brackish marsh is a community dominated by perennial, emergent, herbaceous monocots up to 6 ft tall. The cover is often complete and dense. This community is similar to salt marshes and to freshwater marshes with some plants characteristic of each. The salinity may vary considerably and may increase at high tide or during seasons of low freshwater flow or both. It usually intergrades with coastal salt marsh toward the ocean and occasionally with freshwater marsh at the mouths of rivers, especially in the Delta. Characteristic species include sedges (*Carex harfordii* and *C. obnuta*), saltgrass (*Distichlis sp.*), rushes (*Juncus* sp.), pickleweed (*Salicornia virginica*), bulrushes (*Scirpus acutus* var. *occidentalis, S. americanus, S. californicus,* and *S. robustus*), and cattail (*Typha latifolia*).

Coastal/valley freshwater marsh is a community dominated by perennial emergent monocots up to 12 to 16 ft tall, often forming completely closed canopies. It is found in areas lacking significant current and is permanently flooded by freshwater. Prolonged saturation permits the accumulation of deep, peaty soils. Characteristic species include sedges (*C. lanuginosa* and *C. senta*), nutsedges (*Cyperus esculentus* and *C. eragrostis*), spikerushes (*Eleocharis* sp.), hydrocotyl (*Hydrocotyl verticillata*), mudwort (*Limosella aquatica*), common reed (*Phragmites australis*), bulrushes, bur-reed (*Sparganium eurycarpum* ssp. *eurycarpum*), cattails (*T. angustifolia, T. domingensis,* and *T. latifolia*), and verbena (*Verbena bonariensis*).

More than 80% of the tidal marshes around San Francisco Bay have been filled or converted to other uses; high marshes have been most severely affected. As a result, many of the plant and wildlife species associated with these habitats are threatened, endangered, or candidates for threatened or endangered status.

2-7.1 Special Status Terrestrial Species in the Vicinity of the Pittsburg Power Plant

The following listed (federal and state endangered and threatened) and proposed to be listed terrestrial species occur in the vicinity of and could potentially be affected by the operation, repair and maintenance of the Pittsburg Power Plant.

- The soft bird's-beak (*Cordylanthus mollis* spp. *mollis*) is a member of the snapdragon (Scrophulariaceae) family of plants and is found in the Delta in the intertidal zone of coastal marshes. It is currently state-listed as rare and proposed for listing as endangered by the USFWS.
- The California least tern (*Sterna antillarum browni*) is a member of the gull (Laridae) family of birds, and historically nested along the Pacific coast from San Francisco to Baja California, Mexico. It is currently listed as endangered by the USFWS and CDFG.
- The California black rail (*Laterallus jamaicensis coturniculus*) is a member of the rail (Rallidae) family of birds and occurs in salt, brackish and fresh water wetlands in the Delta. It is currently listed as threatened by the CDFG.
- The California clapper rail (*Rallus longirostris obsoletus*) is a member of the rail (Rallidae) family of birds and occurs in tidal marshes in the Delta. It is currently listed as endangered by the USFWS and CDFG.
- The salt marsh harvest mouse (*Reithrodontomys raviventris*) is a member of the cricetid (Cricetidae) family of mice and occurs in association with northern coastal salt marsh in the Delta. It is currently listed as endangered by the USFWS and CDFG.

These species are described in detail in Appendix A.

CONTRA COSTA POWER PLANT

2-8.0 DELTA HYDROLOGY AND WATER QUALITY IN THE VICINITY OF CONTRA COSTA POWER PLANT

The hydrology of the western Delta is important to the San Francisco Bay estuarine ecosystem. The aquatic environment near the Contra Costa Power Plant fluctuates between a typically freshwater environment in periods of high freshwater inflow and a brackish-water environment when freshwater outflow is low. Seasonal changes in water temperature and salinity affect species composition and abundance of the aquatic community in the area. Water quality in the vicinity of the plant, as in the Delta in general, is influenced primarily by freshwater inflow and tidal circulation. Tidal flow entering the Delta from Suisun Bay influences both the Sacramento and

San Joaquin river systems. Tides are semidiurnal, with two flood and two ebb phases per 24.8-hour tidal day. Mean tidal range at Antioch is about 3.3 ft. The average tidal flow in front of the plant is approximately 170,000 cfs (4,800 m^3/s) (PG&E 1970). The effective volume of water that moves back and forth past the area depends on tidal conditions and freshwater inflow, and has been assumed to be equal to the tidal prism, i.e., the quantity of water passing the power plant between successive tidal phases minus the Delta outflow, calculated as approximately 1.3 billion ft^3 (37 million m^3) (Tetra Tech 1976). Tidal currents within the Delta reverse direction between flood and ebb tide cycles, which has a substantial effect on the size and location of the thermal discharge plumes of both power plants.

Hydraulic characteristics of the mixing zone between freshwater flowing into the Delta from the Sacramento and San Joaquin river systems and saltwater intrusion from San Francisco Bay is characterized by a zone of particle accumulation frequently referred to as the "null zone." Data from Arthur and Ball (1978, 1979) and Kimmerer (1991) have shown that the location of the null zone can be defined by surface salinities ranging from approximately 1 to 6 ppt. These studies have also shown that the location of the null zone, as defined by salinity conditions, varies in response to changes in freshwater inflow. During periods of low inflow (e.g., 3,500-5,000 cfs), the null zone is located adjacent to the Contra Costa Power Plant. The magnitude of freshwater inflow during late winter and spring influences the location of the null zone and the geographic distribution of larval Delta smelt and other species of concern, thereby affecting their susceptibility and exposure to the circulating water systems at the power plant.

2-9.0 AQUATIC HABITATS AND SPECIES IN THE VICINITY OF CONTRA COSTA POWER PLANT

Source waters for the Contra Costa Power Plant circulating water system are characteristic of the estuary that separates the upstream, freshwater Delta from the downstream, saltwater bays. The areas adjacent to the plant contain several types of aquatic habitats, including freshwater and brackish marshes, shallow channel and shoal areas, and the main river channel. Together, these habitats support a diverse aquatic community.

The islands north and west of the Contra Costa Power Plant consist of brackish and freshwater marshes. The area between the shore and the deepwater channel is characterized by water depths of less than 20 ft, a mud, sand, or peat-detritus bottom, and reduced exposure to tidal and river currents. The inshore areas of the shoals are bordered by emergent vegetation. Small crustaceans, particularly mysid shrimp (*Neomysis mercedis*) and amphipods of the genus *Corophium*, inhabit the area and are important food items for young-of-the-year fish. Fish species occurring in the shallow channel and shoal areas adjacent to the power plant include striped bass (*Morone saxatilis*), largemouth bass (*Micropterus salmoides*), salmon (*Oncorhynchus* sp.), longfin smelt (*Spirinchus thaleichthys*), Delta smelt, wakasagi (*H. nipponensis*), threespine stickleback

(*Gasterosteus aculeatus*), tule perch (*Hysterocarpus traski*), Sacramento squawfish (*Ptychocheilus grandis*), gobies (*Acanthogobius flavimanus, Tridentiger bifasciatus*), inland silverside (*Menidia beryllina*), starry flounder (*Platichthys stellatus*), Sacramento splittail (*Pogonichthys macrolepidotus*), carp (*Cyprinus carpio*) and catfish (*Ictalurus* sp.).

River and shipping channels are characterized by depths of more than 20 ft and by strong tidal and river currents (1.1-1.5 fps). Dredged shipping channels are present on the opposite side of the river from the Contra Costa Power Plant. The river bottom generally comprises fine silts and sand. Invertebrates that inhabit this area include bottom-dwelling polychaetes, amphipods, and bivalves, and epibenthic shrimp, primarily *Neomysis mercedis*, *Palaemon macrodactylus*, and *Crangon* spp. The open waters of the lower San Joaquin River serve as a migratory route for several species of anadromous fish that migrate to the freshwater reaches of the tributary rivers to spawn. These fishes include striped bass, steelhead (*O. mykiss*), chinook salmon (*O. tshawytscha*), white and green sturgeon (*Acipenser transmontanus* and *A. medirostris*), and American shad (*Alosa sapidissima*). Many other estuarine and freshwater fish, including Sacramento squawfish, catfish, longfin and Delta smelt, carp, and splittail, occur in these areas.

Threats to the Delta aquatic ecosystem include loss of habitat due to decreased freshwater inflows that have increased salinity; loss of shallow-water habitat due to dredging, diking, and filling; pollution: introduced aquatic species that have disrupted the food chain; entrainment; and altered patterns and timing of flows through the Delta resulting from state, federal and private water diversions. These threats have resulted in the development of the **Sacramento-San Joaquin Delta Native Fishes Recovery Plan** (USFWS 1996) for seven fish species in the Delta. The seven species, Delta smelt, Sacramento splittail, longfin smelt, green sturgeon, Sacramento perch, and spring-run and fall/late fall-run chinook salmon, depend on the Sacramento-San Joaquin Delta for a significant segment of their life history. The recovery plan identifies the following actions needed for recovery for these species.

1. Enhancing and restoring aquatic and wetland habitat in the Sacramento-San Joaquin Delta.

2. Reducing effects of commercial and recreational harvest.

3. Reducing effects of introduced aquatic species on native Delta fishes.

4. Changing and improving enforcement of regulatory mechanisms.

5. Conducting monitoring and research on fish biology and management requirements.

6. Assessing recovery management actions and reassessing prioritization of actions.

7. Increasing public awareness of the importance of native Delta fishes.

Winter-run chinook salmon and steelhead, two other HCP-listed fish species that utilize the Delta, are not included in the Delta Fishes Recovery Plan, but are addressed in the **Recommendations for the Recovery of the Sacramento River Winter-run Chinook Salmon** (NMFS 1996) and the **Steelhead Restoration and Management Plan for California** (CDFG 1996), respectively.

Natural Delta inflow consists of rain runoff during late fall and winter and snowmelt in spring and summer. The major rivers that drain into the Delta are dammed for flood control, water storage, and hydroelectric power generation. The current Delta system is a highly controlled and modified environment. The estuary serves as a water source for local agriculture, industries and municipalities, and state and federal water diversion facilities. The principal mechanism for control of water entering the Delta is through a pair of independent, yet coordinated and cooperative water systems: the Central Valley Project (CVP) operated by the U.S. Bureau of Reclamation, and the California State Water Project (SWP) operated by the Department of Water Resources (DWR). During periods of low Delta inflow, state and federal water exports can alter the direction of flow (reversed flow) in the lower San Joaquin River adjacent to the Contra Costa Power Plant and in many Delta channels. The balance between diversion of freshwater from the Delta and water storage and release from the reservoirs plays a critical part in the regulation and control of physical, chemical, and biological processes in the estuary. The release of stored water during the summer and fall dry seasons has considerably altered the freshwater flow and salinity regimes in the Delta. At the same time, diversions from the estuary of freshwater inflow have altered the total freshwater input to the San Francisco Bay/Delta and the patterns of flow and salinity. Freshwater flow patterns are important to the physical, chemical, and biological processes of the Bay/Delta system. Seasonal reductions in Delta inflow, as a consequence of upstream storage within impoundments and increased diversions and consumptive use, have been identified as major factors affecting the abundance of a variety of Delta fish and macroinvertebrates.

Increased diversions, especially in dry years, results in a reduction in both total outflow and high spring outflows. These reductions can affect salinity, the location of the mixing zone, river flow direction, primary productivity, and survival of larval and juvenile fish. During periods of drought and increased water diversions, the mixing zone is shifted further upstream in the Delta. Since 1984, with the exception of record flood flows of 1986, the mixing zone has been located primarily in the river channels during the entire year because of increased water exports and diversions (Fed. Reg. Vol. [illegible], No. 42, March 5, 19 , Final Rule on Delta smelt). When located upstream, the mixing zone becomes confined to the deep river channels, becomes smaller in total surface area, contains very few shallow areas suitable for spawning, may have swifter, more turbulent water currents, and lacks the high zooplankton productivity that is present in the shallow waters of Suisun Bay. In all respects, the upper river channels provide much less favorable spawning and rearing habitat for Delta smelt than that provided when the mixing zone occurs further down where it occupies a large geographic area and includes extensive shallow areas that provide suitable spawning substrates within the euphotic zone (depths less than 4 m).

Channelization and dredging of Delta waterways in combination with levee construction and reclamation have contributed to changes in water velocities, residence time, hydrologic patterns, and the areal extent of shallow water, shoals, and marsh habitats. The availability of shallow water and marsh habitats within the Delta, which historically provided habitat for a variety of species, has been reduced substantially through reclamation of Delta islands for agricultural use and the filling and diking of areas for industrial and residential use. These changes to the Delta environment have resulted in significant modifications and reductions in habitat availability and suitability for aquatic and terrestrial species.

Data on the status of various aquatic organisms inhabiting the estuary system show a number of changes in species composition and relative abundance of fish and macroinvertebrate populations (Moyle and Herbold 1989, Herbold et al. 1992, and CDFG 1993). Results from these studies have demonstrated the introduction and rapid increase in abundance of fish species such as yellowfin goby and invertebrates including the copepods *Pseudodiaptomous forbesi* and *Sinocalanus doerri* and the clam *Potamocorbula amurensis* during the past decade. Abundances of the copepods *Eurytemora affinis* and *Diaptomus* spp., mysid shrimp (*Neomysis mercedis*), and shrimp (*Palaemon macrodactylus* and *Crangon franciscorum*) have declined in recent years (Herbold et al. 1992).

Federal and State water diversion projects export, by absolute volume, mostly Sacramento River water with some San Joaquin River water. During periods of high export pumping and low to moderate river outflows, however, portions of the San Joaquin River and other channels reverse direction (i.e., negative or positive upstream flow) and flow toward the pumping plants located in the southern Delta. In recent years, the number of days of reversed flow have increased, particularly during the February-June spawning months for Delta smelt (Moyle et al. 1992). During periods of negative flow, out-migrating larval and juvenile fish of many species become disorientated. Net positive riverine flows and estuarine outflows of sufficient magnitude are required for larval and juvenile fish to be carried downstream and into the upper end of the mixing zone of the estuary rather than upstream to the pumping plants. Large mortalities occur as a result of entrainment and predation by striped bass at the various water pumping and diversion facilities. All size classes of Delta smelt suffer near total loss when they are entrained by the pumping plants and water diversions located in the south Delta (Fed. Reg. Vol. 58, No. 42, March 5, 1993, Final Rule on Delta smelt). Very few smelt are effectively salvaged at the federal and State pumping plant screens, and it is unlikely that many Delta smelt survive the handling (Fed. Reg. Vol. 58, No. 42, March 5, 1993, Final Rule on Delta smelt and USFWS 1995).

Although precise estimates of the numbers of native Delta fish species lost as a consequence of entrainment at water diversions within the Delta are not available, DWR has developed estimates of losses for some species at state and federal water project diversions. Estimated entrainment losses of larval Delta smelt less than 21 mm long at the CVP and CWP were 1.2 million in 1992 (DWR 1993). Estimates of the number of juvenile and adult Delta smelt (21 mm and greater) salvaged at the SWP varies throughout the year, with an average monthly estimate of up to 8,000 fish during June (DWR 1993). Expanded salvage estimates of Delta smelt at the SWP between 1976 and 1992 have shown monthly salvage estimates as high as 255,000 Delta smelt in 1976, although the variability in salvage is substantial between months and between years. Additional losses of native Delta fishes occurs as a result of the operation of the Central Valley Project. In addition, there are an estimated 1,800 screened and unscreened agricultural, industrial, and municipal diversions in the Delta. Operation of these diversions results in direct entrainment losses for native Delta fishes and the phytoplankton and zooplankton that provide the food resources for many of these fishes.

2-9.1 Sensitive Aquatic Species in the Vicinity of the Contra Costa Power Plant

The following sensitive aquatic species occur in the vicinity of and could potentially be affected by the operation, repair and maintenance of the Contra Costa Power Plant.

- The Delta smelt is a pelagic member of the smelt family (Osmeridae) that is endemic to the Sacramento/San Joaquin Delta. It is currently listed as threatened by the USFWS and CDFG.

- The longfin smelt is a euryhaline/anadromous member of the smelt (Osmeridae) family that occurs along the west coast of North America. It currently has no official state or federal status.

- The Sacramento splittail is a benthic foraging member of the minnow (Cyprinidae) family that is endemic to the Sacramento/San Joaquin Delta. It is listed as threatened by the USFWS.

- The chinook salmon is an anadromous member of the salmon and trout family (Salmonidae) that occurs along the west coast of North America, as well as Japan and Russia. Three races of chinook salmon are of concern in California; the winter-run, fall/late fall-run, and spring-run. The winter-run is listed as endangered by the NMFS, and the spring-run is listed as threatened by the NMFS and CDFG. The fall/late fall-run was proposed for listing as threatened in March 1998; however, NMFS determined that listing of this ESU was not warranted and the Central Valley fall/late fall run ESU remains a candidate species. (64 Fed. Reg. 50,394 (Sept. 16, 1999)).

- The steelhead is an anadromous member of the Salmon and trout family (Salmonidae) that is endemic to the west coast of North America. The steelhead utilizing the Central Valley river systems are primarily of the winter-run variety. Central Valley steelhead were listed as threatened by NMFS in March 1998.

- The green sturgeon is an anadromous member of the sturgeon family (Acipenseridae) that occurs along the west coast of North America, as well as Japan and Russia. It currently has no official state or federal status.

These species are described in detail in Appendix A.

2-10.0 TERRESTRIAL HABITATS AND SPECIES IN THE VICINITY OF CONTRA COSTA POWER PLANT

Major factors threatening plant and wildlife species in the estuary are habitat loss and degradation, disease, introduced predators and competitors, and pollution. Two-thirds of the 89 species of resident wildlife currently in decline or receiving special attention from the state or federal governments are dependent on wetlands. The natural communities that comprise tidal wetlands, freshwater wetlands, and native uplands, as well as the plant, fish, and wildlife species that depend on those communities, have been significantly reduced in the Delta.

Almost all the land in the central, northern, eastern, and southern Delta is committed to agriculture; the western Delta adjacent to the Contra Costa Power Plant is largely urbanized and industrialized. The Contra Costa Power Plant, as well as chemical, steel, and paper manufacturing industries, are located on the south shore of the San Joaquin River in the western Delta near the city of Antioch. No sensitive terrestrial species are known to occur on the Contra Costa Power Plant property, nor could any terrestrial species be affected by the operation, repair, and maintenance of the power plant.

MONTEZUMA ENHANCEMENT SITE

2-11.0 EXISTING CONDITIONS AND SENSITIVE AQUATIC AND TERRESTRIAL SPECIES IN THE VICINITY OF THE MONTEZUMA ENHANCEMENT SITE

Due to the complex interrelationship between existing conditions and proposed actions at the Montezuma Enhancement Site and the impacts on the sensitive aquatic and terrestrial species in the vicinity, this discussion has been deferred to Section 4-4.0.

Section 3
BOUNDARIES, ACTIVITIES, AND IMPACTS

INTRODUCTION

Under Section 10(a)(2)(A) of the ESA and the ESA implementing regulations (50 CFR §§ 17.22(b)(1), 17.32(b)(1), and 222.22), an HCP submitted in support of an incidental take permit must detail "the impact that will likely result from such taking." Furthermore, the USFWS and NMFS HCP Handbook lists four "subtasks" to be completed to determine the likely effects of an activity on the fish, wildlife and plant species intended to be addressed in an HCP: (a) delineation of the HCP boundaries or plan area; (b) collection and synthesis of biological data for species covered by the HCP; (c) identifying activities proposed in the plan area that are likely to result in incidental take; and (d) quantifying anticipated take levels. As stated in the USFWS and NMFS HCP Handbook, "...proposed incidental take levels can be expressed in the HCP in one of two ways: (1) in terms of the number of animals to be 'killed, harmed, or harassed' if those numbers are known or can be determined; or (2) in terms of habitat acres or other appropriate habitat units (e.g., acre-feet of water) to be affected generally or because of a specified activity, in cases where the specific number of individuals is unknown or indeterminable." SE has chosen the latter method in the HCP, and has consequently expressed take as either acres or acre-feet of water, where appropriate. Where possible, the potential level of take of sensitive fish species has been quantified, based on the anticipated level of habitat take.

In addition, the USFWS and NMFS HCP Handbook lists several additional impact assessment elements to help expedite the Section 7 consultation process under the ESA: (a) addressing significant indirect effects of the project on federally listed species; (b) addressing jeopardy to federally listed plants; and (c) addressing effects on critical habitat. Section 2 of this HCP presents the biological data for species covered in the HCP. This section addresses the HCP boundary, activities likely to result in incidental take, quantification of take, and significance of take. The impacts discussion in this section also includes assessment of indirect effects on the HCP species, effects on listed plants, and effects on critical habitat.

3-1.0 HABITAT CONSERVATION PLAN BOUNDARIES

The Pittsburg and Contra Costa Power Plants HCP boundaries include areas that are likely to be affected by SE's construction, maintenance, repair, operation, habitat enhancement, and monitoring activities. The boundaries of the properties within the HCP Area are shown in Figure 3-1. The boundaries are described as follows:

- Pittsburg HCP Area means: the parcel of land bounded on the northerly side by the Contra Costa/Solano County line; bounded on the easterly side by the Pittsburg City limit line and its northerly prolongation to said County line; bounded on the southerly side by the following described line: beginning at the intersection of said Pittsburg City limit line with the southerly line of the old Sacramento Northern Railroad right-of-way and running westerly along said Railroad right-of-way line to the northwest corner of APN 85-270-035, thence southerly along the westerly boundary line of APN 85-270-035 to the northerly boundary line of Willow Pass Road, thence westerly along the northerly boundary line of Willow Pass Road to the northerly boundary line of APN 96-100-024, thence westerly along said northerly boundary line to the northwest corner of APN 96-100-024, thence southerly along the westerly boundary line of APN 96-100-024 to the northerly boundary line of the Atchison, Topeka and Santa Fe Railroad (AT&SFRR), thence westerly along said AT&SFRR boundary line to the westerly boundary line of Section 12, Township 2 North, Range 1 West, MDB&M, and the end of said line; bounded on the westerly side by a line described as follows: beginning at the intersection of the northerly boundary line of said AT&SFRR with the westerly boundary line of said Section 12, and running northerly along said westerly boundary line of Section 12 approximately 3,000 feet to the center of an unnamed Slough, thence following the center line of said slough in a circular route heading westerly and northerly until said line intersects said County line.

- Contra Costa HCP Area means: the parcel of land bounded on the northerly side by the Contra Costa/Sacramento County line; bounded on the westerly by the westerly boundary line of the parcels of land described and designated PARCEL ONE and PARCEL TWO in the deed from American Securities Company to Pacific Gas and Electric Company, dated September 28, 1948, and recorded in Book 1304 of Official Records at page 308, Contra Costa County Records and the northerly prolongation of the westerly boundary line of said PARCEL TWO to said County line; bounded on the southerly side by the northerly boundary line of Wilbur Road; and bounded on the easterly side by the easterly boundary line of said PARCEL ONE and PARCEL TWO and the easterly boundary line of the parcel of land described in the deed from Jeni Mori and Italo Mori, wife and husband to Pacific Gas and Electric Company, dated February 14, 1949, and recorded in Book 1431 of Official Records at page 127, Contra Costa County Records, and the northerly prolongation of said easterly boundary line of PARCEL TWO to said County line.

- The Montezuma HCP Area means: the parcel of land bounded on the easterly side by the easterly boundary line of the parcel of land described and designated PARCEL NO. THREE in the deed from Hazel L. Stratton to Pacific Gas and Electric Company, dated September 21, 1964, and recorded in Book 1294 of Official Records at page 628, Solano County Records and its southerly prolongation to the Solano/Sacramento County line; bounded on the southerly side by said Solano/Sacramento County line; bounded on the westerly side by the westerly boundary line of said PARCEL NO. THREE and its southerly prolongation to said County line; and bounded on the northerly side by a line which begins at the most easterly corner of said PARCEL NO. THREE and runs westerly along the northerly boundary line of said PARCEL NO. THREE to its intersection with the southerly boundary line of Stratton Road, thence leaving said northerly boundary line and running westerly along said southerly

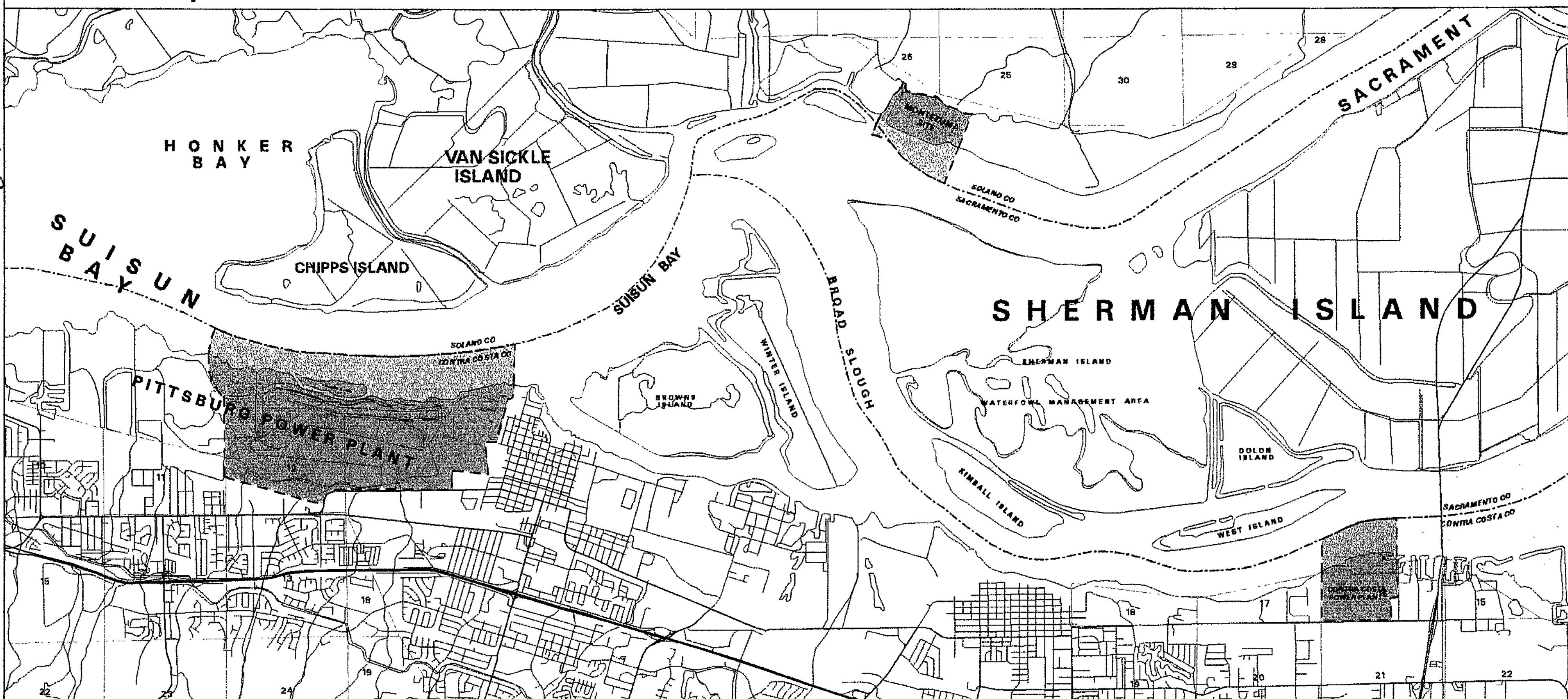
Figure 3-1.

Pittsburg and Contra Costa Power Plants Habitat Conservation Plan

HCP Boundary

Pittsburg Power Plant		Contra Costa Power Plant		Montezuma Site	
1,199 Acres	PG&E Property	187 Acres	PG&E Property	139 Acres	PG&E Property
453 Acres	Open Water	106 Acres	Open Water	93 Acres	Open Water
1,652 Total		293 Total		232 Total	

HCP Boundary
Roads
Hydrologic features
PLS section lines



boundary line of Stratton Road to its intersection with said westerly boundary line of said PARCEL NO. THREE and the terminus of said line.

The HCP boundaries for each of the three sites extend into the adjacent water bodies (identified in Figure 3.1) to include potential monitoring locations described in the HCP..

Critical habitat for Delta smelt has been designated in the Pittsburg and Contra Costa Power Plants and Montezuma Enhancement Site HCP boundary area. Critical habitat for winter-run chinook salmon has been designated in the Pittsburg Power Plant and Montezuma Enhancement Site HCP boundary area. Critical habitat for the California clapper rail, least tern, and salt marsh harvest mouse has not been designated within the HCP boundaries, but draft recovery plans currently under review are expected to identify important habitats within some or all of the three HCP boundary areas. Impacts on critical habitats are discussed for the appropriate species for each HCP boundary area in the following sections.

3-2.0 POWER PLANT ACTIVITIES AND IMPACTS

This section describes construction, maintenance, repair, and operation activities of the Pittsburg and Contra Costa Power Plants that could result in the incidental take of sensitive fish, wildlife, and plant species. Generally, impacts to sensitive wildlife and plant species may occur from activities associated with power plant maintenance and repair; impacts to aquatic species may occur when water is diverted for condenser cooling with additional minimal effects from thermal discharges. Pittsburg Power Plant issues are discussed starting in section 3-2.1 and Contra Costa Power Plant issues are discussed starting in section 3-2.6.

PITTSBURG POWER PLANT

3-2.1 Construction, Maintenance, and Repair Activities-Pittsburg Power Plant

SE is proposing a phased adaptive management plan for the HCP conservation measures. Phase I will be comprised of demonstration testing of an Aquatic Filter Barrier (AFB) at Contra Costa Power Plant while using Variable Speed Discharge (VSD) Flow Minimization at Pittsburg Power Plant. (See Appendix E for a full description of VSD.) Phase II is comprised of continued use of the AFB at CCPP if it is shown effective and implementation of a demonstration of the AFB at Pittsburg Power Plant. Should the AFB be found ineffective at the Pittsburg Power Plant, VSD will be implemented in lieu of AFB. Phase III is the implementation of habitat conservation and enhancement measures at the Montezuma Enhancement Site.

Implementation of the proposed HCP conservation measures may include construction activities necessary to deploy, monitor and maintain an AFB at the Pittsburg Power Plant. Such activities would take place in Phase II at the Pittsburg Power Plant and are contingent on the results of a biological monitoring and sampling program that was developed in consultation with USFWS, NMFS, and the CDFG. If the biological monitoring and sampling program in the Phase I demonstration at the Contra Costa Power Plant demonstrates that AFB is effective in substantially reducing impacts to HCP species, then the AFB would be deployed at the Pittsburg Power Plant. Further, the safe and efficient operation of the Pittsburg Power Plant requires continual maintenance and repair. Maintenance and repair means all current and future activities (dismantling, reconstruction, environmental retrofitting, etc.) necessary to ensure the legal, safe, and efficient operations within the HCP Area.

Construction Activities Covered in the HCP. Those activities which may result in incidental take of sensitive fish, wildlife or plant species include:

- Removal of riprap and emergent vegetation in an area of approximately twenty feet wide by forty-feet long along the shoreline at the Pittsburg Power Plant in order to anchor and seal each end of the AFB

- Placement of an AFB of approximately 3,200 feet long in the water column in a semicircular arc, encompassing an area of approximately twenty-eight acres; including placement of the AFB on the bottom sediments comprising an area of approximately 15 feet wide over the length of the AFB; installation of anchors, monitoring instruments, tethering lines and airlines.

- Clearing of an area of approximately 20 feet x 50 feet and construction thereon of a small boat ramp necessary to maintain and conduct biological monitoring and sampling of the AFB and to utilize for construction and maintenance activities of the AFB.

Maintenance Activities Covered in the HCP. Those activities which may result in incidental take of sensitive fish, wildlife, or plant species include:

- Maintenance and repair of power plant facilities, including, but not limited to, all related buildings, structures (including intake, AFB, shoreline maintenance, other screening systems and intake forebay dredging), fixtures, improvements, land and water uses, equipment, machinery, and operational accouterments and appurtenances.

- Maintenance and repair of electric transmission and distribution systems, whether above or below ground, including, but not limited to, all related towers, poles, transformers, anchor lines, anchors, vaults, manholes, and access roads, together with other related fixtures, equipment, machinery, improvements, and operational accouterments and appurtenances.

- Maintenance and repair of electrical substations, including all related buildings, structures, land uses, poles, lines, anchor lines, anchors, pads, transformers, towers, together with other operational improvements, fixtures, equipment, machinery, and operational accouterments and appurtenances.

- Maintenance and repair of telecommunication systems, including all related buildings, structures, land uses, towers, poles, antennae, vaults, lines, switches, and other related fixtures, equipment, machinery, improvements, and operational accouterments and appurtenances.

- Maintenance and repair of natural gas and fossil fuel systems, including, but not limited to, all related buildings, docks, moorings, structures, storage facilities, pipes, equipment, fixtures, equipment, machinery, improvements, and operational accouterments and appurtenances.

- Maintenance and repair of other facilities, above or below ground or water, such as, but not limited to, roads, access routes, levees, vegetation (including grazing to reduce fire hazard), waterways, fences, fuel lines, water pipes, conduits, antennae, or lines of any kind, together with other related fixtures, poles, towers, equipment, machinery, improvements, and operational accouterments and appurtenances.

- Maintenance and repair of all structures, facilities, and equipment, above or below ground, in our out of water, necessary or appropriate for maintaining, inspecting and monitoring the AFB.

Maintenance Activities Not Covered in the HCP. Maintenance and repair activities not related to power plant operations on property on and adjacent to the power plant site may occur within the HCP boundary and could also result in the incidental take of sensitive fish, wildlife and plant species. However, these activities are excluded from this HCP because they are either not conducted by SE or they are subject to permitting processes that already require the federal and state Endangered Species Acts to be satisfied before the activity is authorized. These excluded activities include:

- Mosquito abatement;
- Vegetation management
- Underground pipelines maintenance,
- Utility equipment maintenance,
- Hazardous Materials site remediation; and
- Dock and fishing access pier maintenance and repair.

3-2.2 Construction, Maintenance, and Repair Impacts

Table 3-1 summarizes the estimated take of sensitive species from the anticipated construction, maintenance and repair activities at the Pittsburg Power Plant during the term of the HCP using VSD Flow Minimization. Should AFB be demonstrated effective at the Contra Costa Power Plant during Phase I, it would be implemented at the Pittsburg Power Plant during Phase II. SE estimates that impacts to HCP aquatic species should be reduced by 80-99 percent if the AFB operates as expected. Construction and deployment of AFB would likely result in little mortality or injury to listed species as it would be installed during periods in which larvae and juveniles would either not be present or at relatively low abundance. If AFB is deployed, impacts to listed aquatic species include the loss of 28 acres of Bay-Delta aquatic habitat which includes 17 acres of nearshore habitat. Further, once deployed, the interior of the AFB would be electrofished and/or seined, to return all listed fish species back to the Delta outside the AFB enclosure. Deployment of the AFB would include impacts to terrestrial species substantially similar to that shown in Table 3-1. As noted, implementation of AFB should, if it performs as expected, result in fewer impacts to sensitive aquatic species.

Table 3-1. Anticipated Take of Sensitive Species Resulting from the Maintenance and Repair Activities at Pittsburg Power Plant over the 15-year Permit Period

SPECIES	Estimated take [1]
Delta smelt	The number of individuals supported by 150 ac ft of water [2]. (Estimated to be between 5-120 individuals)[3]
Longfin smelt	The number of individuals supported by 150 ac ft of water [2]. (Estimated to be between 25-70 individuals)[3]
Winter-run chinook salmon	The number of individuals supported by 150 ac ft of water [2]. (Estimated to be between 0-1 individual)[3]
Spring-run chinook salmon	The number of individuals supported by 150 ac ft of water [2]. (Estimated to be between 0-6 individuals)[3]
Fall/late fall-run chinook salmon	The number of individuals supported by 150 ac ft of water [2]. (Estimated to be between 0-6 individuals)[3]
Steelhead	The number of individuals supported by 150 ac ft of water [2]. (Estimated to be between 0-1 individual)[3]
Sacramento splittail	The number of individuals supported by 150 ac ft of water [2]. (Estimated to be between 35-45 individuals)[3]
Green sturgeon	The number of individuals supported by 150 ac ft of water [2]. (Estimated to be between 0-1 individuals)[3]
California clapper rail	The temporary or permanent loss of 1.5 acres of suitable habitat [4]
California black rail	The temporary or permanent loss of 1.5 acres of suitable habitat
California least tern	The temporary or permanent loss of 4.0 acres of suitable nesting habitat[5]
Salt marsh harvest mouse	The temporary or permanent loss of 0.75 acre of suitable habitat
Soft bird's-beak	A maximum of 5 individual plants

1 Take is defined under the ESA as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct."
2 Take based on estimate of annually disturbing 0.5 surface-acres of water to a depth of twenty feet for the term of the permit (15 years).
3 Based on 316(b) 1978-79 and 1986-92 density (# per acre ft) values multiplied by 150.
4 For purposes of complying with the ESA, it is estimated that 1.5 acres of suitable habitat has the potential to support a maximum of 7 pairs. Estimated habitat amount based on Table 3-2.
5 For purposes of complying with the ESA, it is estimated that 4.0 acres of suitable habitat has the potential to support a maximum of 8 pairs. Monitoring of California least tern between 1984 and 1996 has documented no more than 4 pairs and 4 chicks in any one year at the site.

Terrestrial Species. The impacts of the maintenance and repair activities on sensitive terrestrial species depend on the type of activity (ground disturbing, vehicle or equipment use, foot access only, etc.); the location of the activity (sensitive habitat or previously disturbed area); and the amount of surface disturbance, if any, caused by the activity. Potential impacts include:

- Harassment or harm to sensitive species may result from vehicle access, excavation activities, vegetation removal, and use of heavy equipment.

- Damage to sensitive habitats may result from vehicle access, excavation activities, vegetation removal, and use of heavy equipment. Damage may include the destruction of dens, burrows, nests, or other important features of sensitive habitats, and soil compaction.

- Loss of sensitive habitat may result from the installation of permanent facilities in areas that support populations of sensitive species.

- Changes in plant community productivity, diversity, and/or stability may result from excavation activities, vegetation management, use of heavy equipment, and revegetation efforts.

- Barriers to species movement may result from the installation of pipelines, fences, or other barriers. The systematic removal of vegetation, necessary for maintenance, may prevent movement of some species.

- Dispersal corridor for non-native species may result from significant excavation and ground disturbing activities can encourage the spread of non-native plant and animal species.

Table 3-2 lists the maintenance and repair activities and the potential impacts and the amount of surface disturbance (removal or destruction of existing vegetation) that may result. Mitigation for impacts to terrestrial species habitats will be conducted either on site or at a site suitable to the USFWS and CDFG in accordance with the compensation ratio shown in Table 4-1.

Table 3-2 reflects potential impacts during Phase I; however, if AFB is demonstrated effective at the Contra Costa Power Plant, it would be implemented at Pittsburg during Phase II. Additional ground disturbing activity would include the construction of a small boat ramp and clearing of riprap and riparian vegetation so that the AFB achieves the necessary seal at the water and shoreline margin. Monitoring, inspecting and determining the effectiveness of the AFB itself would likely result in the temporary loss of 0.04 acres of emergent vegetation at the shoreline in order to deploy and maintain the AFB. In addition, an area of approximately 0.023 acres of emergent vegetation and riprap would be replaced with a boat ramp which is necessary in order to maintain the AFB and to execute the biological monitoring program. Otherwise, impacts would be similar to those set forth in Table 3-2.

Table 3-2. Anticipated Potential Impacts and Typical Ground Disturbance Resulting From Typical Maintenance and Repair Activities at Pittsburg Power Plant Over the 15-year Permit Period

TYPICAL ACTIVITY	Potential impacts	Typical ground disturbance [1]	
		Temporary	*Permanent*
Maintenance Activities		(Acres)	(Acres)
Facility Inspection using existing access routes	Harassment or harm to sensitive species[2]	0	0
Electric Insulator Washing	Harassment or harm to sensitive species[2]	0	0
Facility Maintenance	Harassment or harm to sensitive species[2] Damage to sensitive habitat		0
AFB Deployment and Maintenance	Harassment or harm to sensitive species[2]	0.06	0.06
Repair Activities			
Electric System Outage Repair	Harassment or harm to sensitive species[2] Damage to sensitive habitat	0 - 1.5	0
Infrastructure Repair (culverts, levees, waterways, access roads, fences, etc.)	Harassment or harm to sensitive species[2] Damage to sensitive habitat Loss of sensitive habitat Changes in plant community productivity, diversity, and/or stability	0 - 2	0 – 1
Electric System, Radio and Telecommunication Tower Replacement and Repair	Harassment or harm to sensitive species[2] Damage to sensitive habitat	< 0.10	0
Electric System Pole and Equipment Replacement and Repair	Harassment or harm to sensitive species[2] Damage to sensitive habitat	< 0.10	0
Above-ground Electric Line Reconductoring	Harassment or harm to sensitive species[2] Damage to sensitive habitat	0.25 per mile	0
Vegetation Management (fire control activities including discing, grazing, and mowing)	Harassment or harm to sensitive species[2] Damage to sensitive habitat Changes in plant community productivity, diversity, and/or stability Barriers to species movement Dispersal corridor for non-native species	0 - 3	0
Underground Linear Facility Replacement (waterline, fuel line, natural gas pipeline, petroleum line, etc.)	Harassment or harm to sensitive species[2] Damage to sensitive habitat Changes in plant community productivity, diversity, and/or stability Barriers to species movement Dispersal corridor for non-native species	2 - 6 per mile	< 0.10 per mile

[1] Ground disturbance shown representative of each activity. More than one activity may occur annually and activities may occur several times annually.
[2] Harassment and harm as they are defined in the ESA.

Aquatic Species. The construction, deployment, maintenance and repair activities are broken down into two parts. In Phase I, impacts to sensitive aquatic species that could result are those associated with the cooling water intake and discharge system. These activities could result in direct mortality to sensitive species as a result of excavation activities and use of heavy equipment or machinery. Take could result primarily from vehicle and equipment use during the maintenance and repair activities. The estimated take of sensitive species during the term of the permit resulting from maintenance and repair activities is reported in the totals in Table 3-1.

In Phase II, assuming AFB is demonstrated effective at the Contra Costa Power Plant and is deployed at Pittsburg, impacts to sensitive aquatic species are those that could result from deployment of the AFB which could encircle sensitive species and deprive them from access to the Delta. The AFB area will, however, be electrofished and/or seined and captured sensitive species immediately returned to the Delta. Further, deployment is planned during periods when larvae and juveniles of sensitive species are either not present or are relatively low in abundance. Laying of anchors and cables, however, may result in short-term increases in suspension of bottom sediment, but should be localized and result in few impacts to sensitive species.

3-2.3 Environmental Setting and Operation Activities

Operation of the Pittsburg Power Plant requires significant volumes of Delta water for condenser cooling that may result in the take of sensitive aquatic species. The following is a description of the environmental setting and the operation of the circulating cooling water systems at the power plant.

Pittsburg Power Plant is located at the transition between the lower Sacramento-San Joaquin Delta system and the San Francisco Bay system (Figure 3-1). The plant is located on the south shore of Suisun Bay near Pittsburg, just west of the confluence of the Sacramento and San Joaquin rivers, and approximately 40 miles northeast of San Francisco. The plant is 48 miles (78km) by water from the Golden Gate Bridge. The land elevation within 3 square miles is often near or below sea level.

Suisun Bay is a large, shallow embayment that is influenced by freshwater inflow from a 64,000-square-mile drainage basin. The bay fluctuates from a freshwater to a brackish water environment. The salinity and water flow fluctuation has been dampened through significant damming on the rivers entering the Delta. This has created higher than natural summer flows and lower than natural winter flows, especially in drier years. When water flows are low (<10,000 cfs), the brackish water transition between fresh and salt water lies east of the power plant. With flows greater than 50,000 cfs, the brackish water transition occurs downstream in Carquinez Strait or San Pablo Bay. Due to the large variability in flow rates, salinity in Suisun Bay is highly variable, typically ranging from freshwater to about one third that of seawater (10 ppt) during average years. Mean monthly salinity ranges from 0.1 to 5 ppt. During periods of drought, salinity ranges from 0.1 to 12.6 ppt in the vicinity of the power plant.

Eastern Suisun Bay, in the vicinity of the power plant, is generally shallow (<30 ft) except for two deep shipping channels that are periodically dredged. These ship channels are approximately 900 ft offshore of the plant. In general, nearby islands within the western Delta are surrounded by marshes or mudflats, except where they are exposed to strong river currents, which scour banks and levees.

Freshwater inflows are highly regulated through industrial, municipal, agricultural diversions, and numerous water storage and diversion projects. Consequently, salinity and flow patterns are highly variable in the estuary. Ambient water temperatures range from about 44°F during winter to 75°F in late summer. Tidal conditions near the Pittsburg Power Plant are semi-diurnal and have a mean tidal range of 3.3 ft. Average flow velocity at ebb tide is 2.2 fps, and at flood tide is 1.7 fps. Average tidal flow in front of the plant is 170,000 cfs.

The Pittsburg Power Plant is a natural gas fueled plant. It consists of seven units with a total generating capacity of 2,060 MWe (megawatts electrical). The seven units were commissioned in three phases; Units 1-4 in 1954, Units 5 and 6 in 1960, and Unit 7 in 1961. All units except Unit 7 use once-through circulating water. Unit 7 water is cooled through two mechanical-draft cooling towers and a large cooling water pond. This closed-cycle system uses about 45 cfs of make-up water from the Units 1-4 intake structure. Circulating cooling water from all seven units is discharged at five submerged outfall structures located about 10 ft offshore in about 10 ft of water. Table 3-3 gives design circulating water flows for each unit. The maximum design flow of the Pittsburg Power Plant Power Plant is 1,641 cfs as shown in Table 3-3.

Table 3-3. Electrical Output and Circulating Cooling Water Flows for Each Unit at Pittsburg Power Plant

	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Total
Capacity (MWe)	170	170	170	170	330	330	720	2,060
Flow (cfs)	220	220	220	220	358	358	45	1,641
Volume (ac-ft/day)	436.4	436.4	436.4	436.4	710.1	710.1	89.3	3255.1

The circulating cooling water absorbs heat during plant operation and is discharged at elevated temperatures. The potential impacts of the heated water on organisms in the receiving waters are addressed in Section 3-2.4.3, and include behavioral avoidance and attraction, migration blockage, sublethal stresses, and acute mortality. The differences between discharge and ambient temperatures for Units 1-4 and Units 5&6 during studies conducted in 1978-79 are shown in Figures 3-2 and 3-3 (data from 316(b) demonstration, Ecological Analysts, Inc. 1981a).

3-2.3.1 Units 1-4 Circulating Cooling Water System

The circulating cooling water system serving Units 1-4 is depicted in Figure 3-4 and shown schematically in Figure 3-5. The intake, located on the shoreline, consists of bar racks and traveling screens. Circulating water pumps serving the individual units are located about 30 ft behind the screen structure. Each unit is equipped with two circulating water pumps that

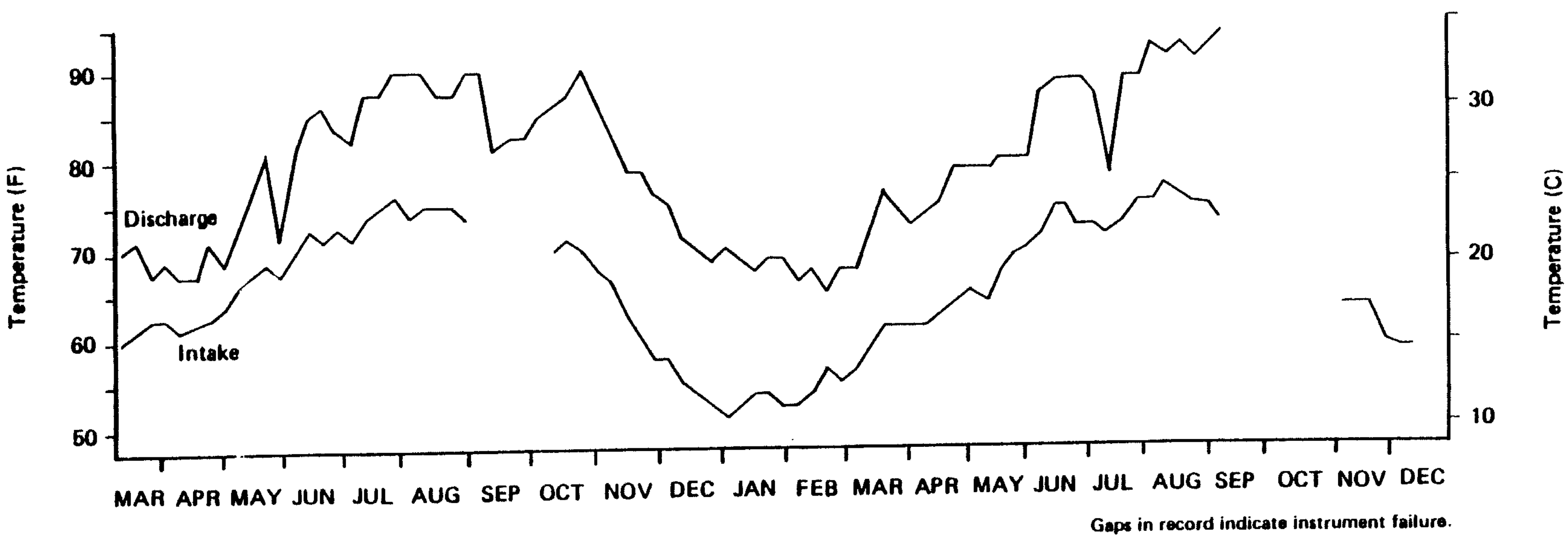


Figure 3-2. Average weekly intake and discharge temperatures at Pittsburg Power Plant Units 1-4 (March 1978-December 1979).

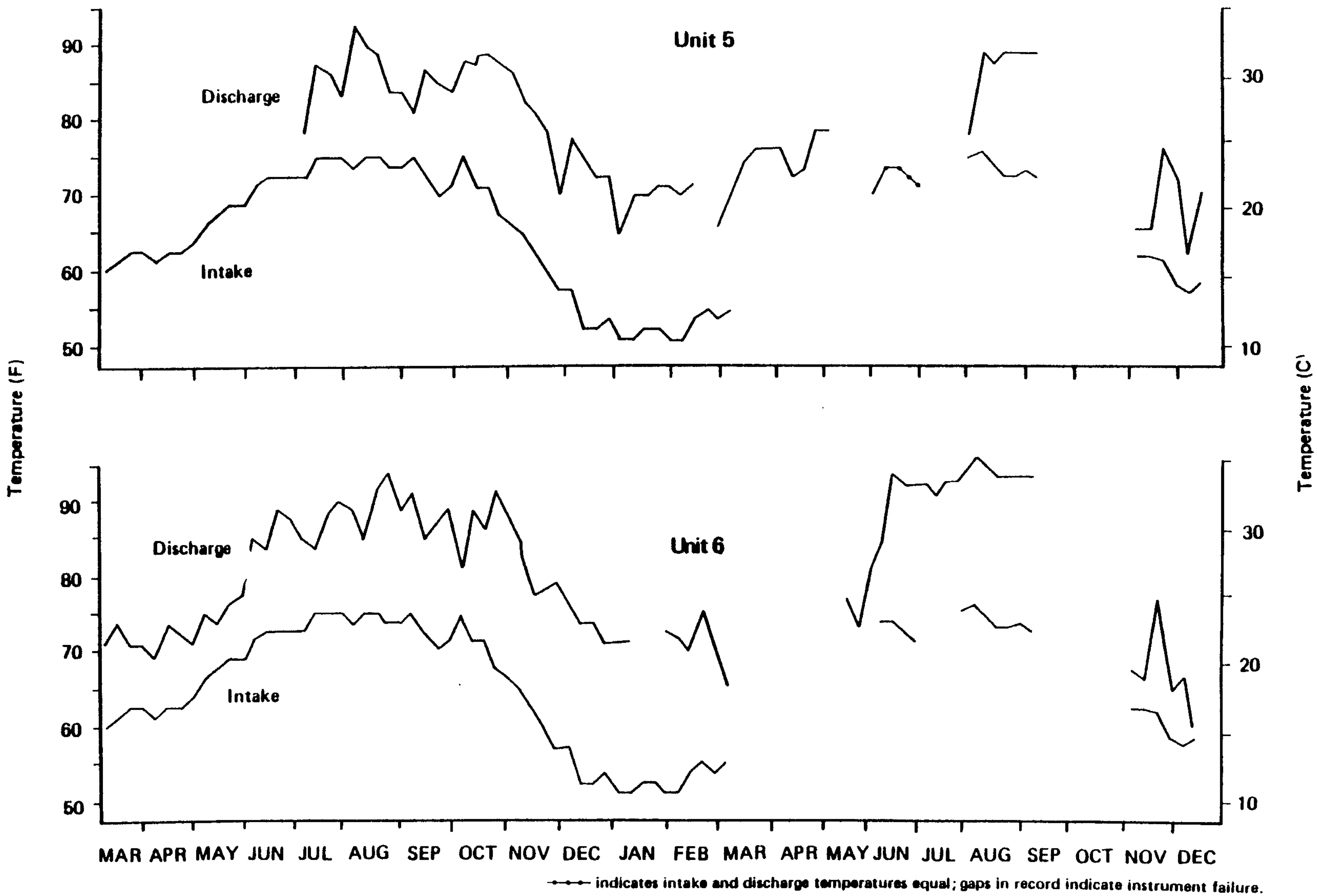


Figure 3-3. Average weekly intake and discharge temperatures at Pittsburg Power Plant Units 5 and 6 (March 1978-December 1979).

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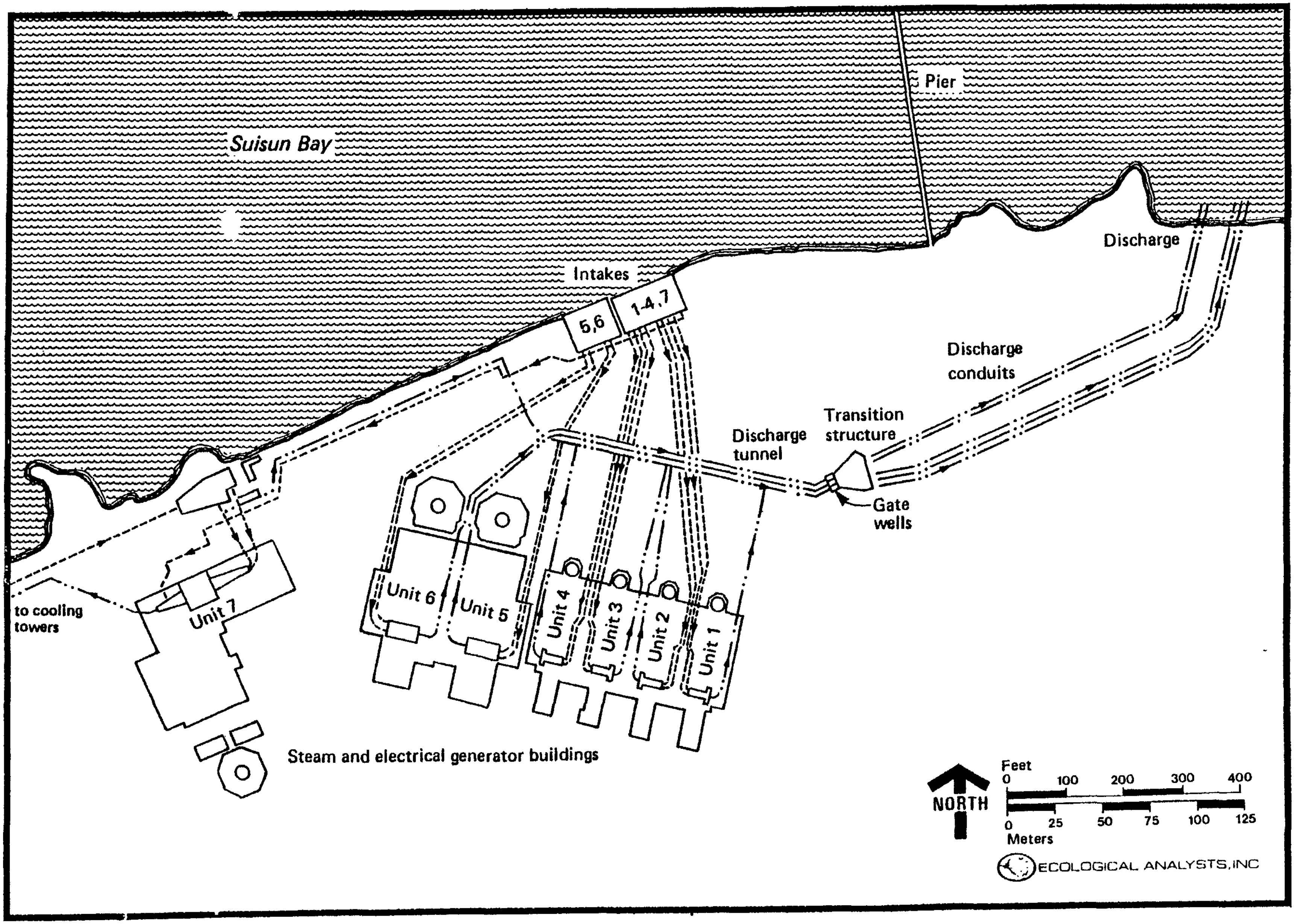

Figure 3-4. General configuration of Pittsburg Power Plant circulating water system.

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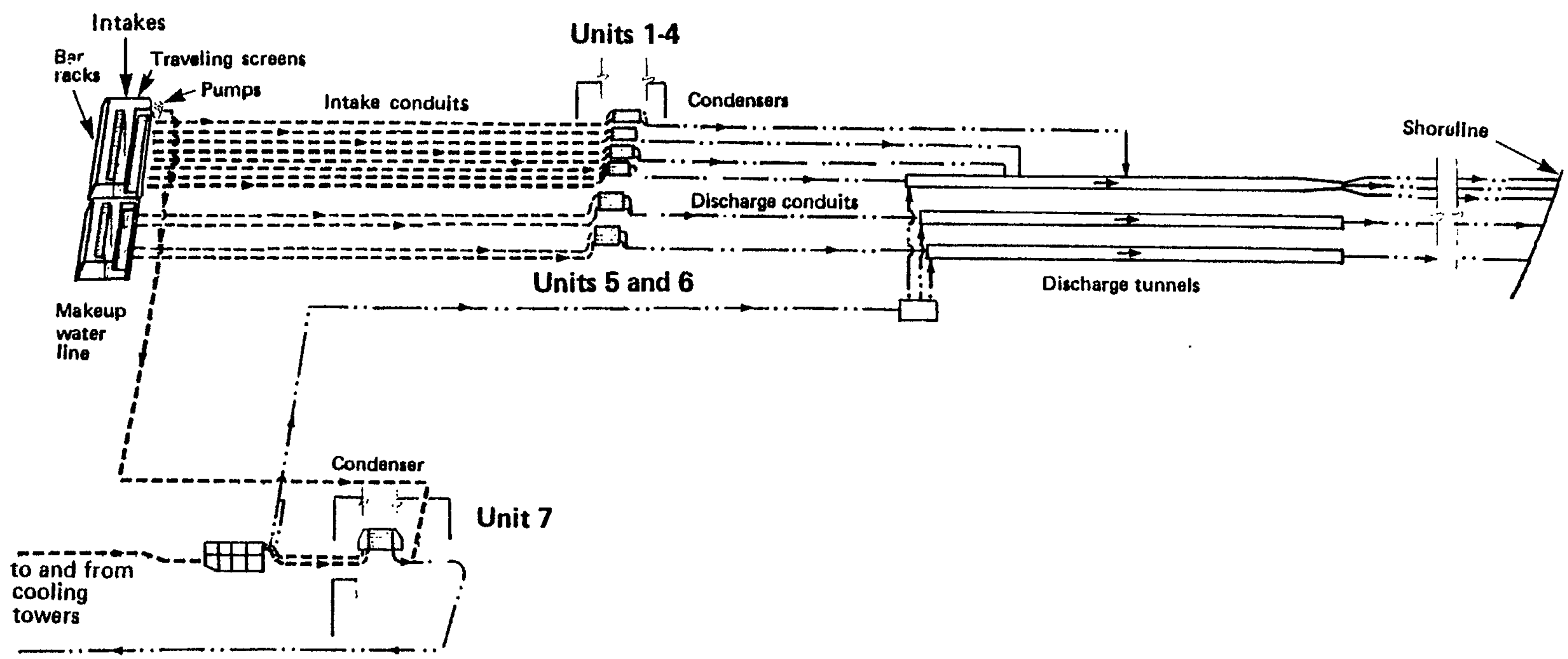

Figure 3-5. Schematic diagram of the Pittsburg Power Plant circulating water system.

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discharge into separate pressure conduits, each supplying one-half of a unit's steam condenser. Circulating water from the condenser discharge conduits of Units 1-4 flows into a common rectangular conduit, separates into three parallel conduits at a gate well, and is discharged from a submerged outfall located approximately 30 ft offshore at the northeast corner of the plant site. Specifications of the system are presented in Table 3-4. Figure 3-6 shows the major features of the intake structure.

Table 3-4. Specifications of the Circulating Water System at Pittsburg Power Plant

SPECIFICATION	Units 1-4	Units 5 and 6	Unit 7
Bar racks			
Number	8	6	Uses Units 1-4 intake
Location	Shoreline	Shoreline	
Spacing O.C. (in.)	4	4	
Bar size (in.)	3 x 0.04	3 x 0.04	
Traveling screens			
Location	Shoreline	Shoreline	Uses Units 1-4 intake
Number	7	6	
Manufacturer	Link Belt	Link Belt	
Mesh size (in.)	0.375	0.375	
Pumps			
Location	Onshore	Onshore	Onshore
Number per unit	2	2	3
Manufacturer	Foster Wheeler	Ingersoll-Rand	NA
Type	Mixed flow vertical single-stage	Mixed flow vertical single-stage	Mixed flow vertical single-stage
Capacity (each pump)			
Cfs	109.8	178.8	22.5
Gpm	49,300	80,250	10,100
Pressure conduits to condenser			
Number	2	2	NA
Diameter (ft.)	4.5	5.5	
Length (ft.)	600 (Units 1&2)	550 (Unit 5)	
	550 (Units 3&4)	675 (Unit 6)	
Condensers			
Number of tubes	9,548	11,300	16,172
Tube material	Aluminum/brass	Aluminum/brass	Copper/nickel
Tube O.D. (in.)	0.875	1	1.125
Tube length (ft.)	30	44	38
Design delta-T (°F)	15	17.3	NA
Discharge Conduits			
Number	1	1	Uses Units 1-4 discharge
Size (ft.)	6.5 x 7	7 x 7	
Length (ft.)	1,360 (Unit 1)	1,760	
	1,510 (Unit 2)		
	1,515 (Unit 3)		
	1,690 (Unit 4)		

SPECIFICATION	Units 1-4	Units 5 and 6	Unit 7
Approximate Travel Time(sec.)			
River to pumps	55	60	
Pumps to condenser	97 (Units 1&2)	80 (Unit 5)	
	90 (Units 3&4)	92 (Unit 6)	
Through condenser	4.3	6.3	
Condenser to discharge	184 (Unit 1)	323	
	206 (Unit 2)		
	214 (Unit 3)		
	237 (Unit 4)		
Total through plant	341 (Unit 1)	470 (Unit 5)	
	363 (Unit 2)	482 (Unit 6)	
	364 (Unit 3)		
	387 (Unit 4)		
Total heated	189 (Unit 1)	330	
	211 (Unit 2)		
	212 (Unit 3)		
	235 (Unit 4)		
Total chlorinated [1]	286 (Unit 1)	410 (Unit 5)	
	308 (Unit 2)	422 (Unit 6)	
	309 (Unit 3)		
	332 (Unit 4		
Design water velocities (fps)			
Through intake tunnel	NA	NA	Uses Units 1-4 intake
Approach to bar racks	0.04	0.5	
Through bar racks	0.5	0.6	
Approach to screens	0.8	0.8	
Through screens	2.0	1.5	
Screens to pumps	NA	NA	
Pumps to condenser	7.1	7.5	
Through condenser	7.0	7.0	
Condenser to discharge	7.2	5.9	

[1] Based on the time between chlorine injection and point of discharge.

Bar racks spaced 4 inches on center are located about 15 ft in front of the vertical traveling screens and prevent the entry of large objects into the circulating water system (Table 3-4 and Figure 3-6.). As cooling water is drawn into the power plant by the circulating water pumps, take of aquatic species occurs via entrainment and impingement. The traveling screens have a mesh size of 3/8 inch. Debris, along with fish and invertebrates retained by the screens, is removed during screen rotation and washing, which is initiated either by a timer, at about 4-hour intervals under normal operating conditions, or when the across-screen hydraulic differential exceeds a predetermined maximum. During screen washing, high-pressure (95-psi) spray nozzles wash debris and impinged organisms into a surrounding sluiceway that empties into a screenwash wet well, which also receives the screenwash from the Units 5 and 6 traveling screens. The screenwash discharge is returned to the bay by three large-diameter trash pumps of 2,800 gallons per minute (gpm) (6

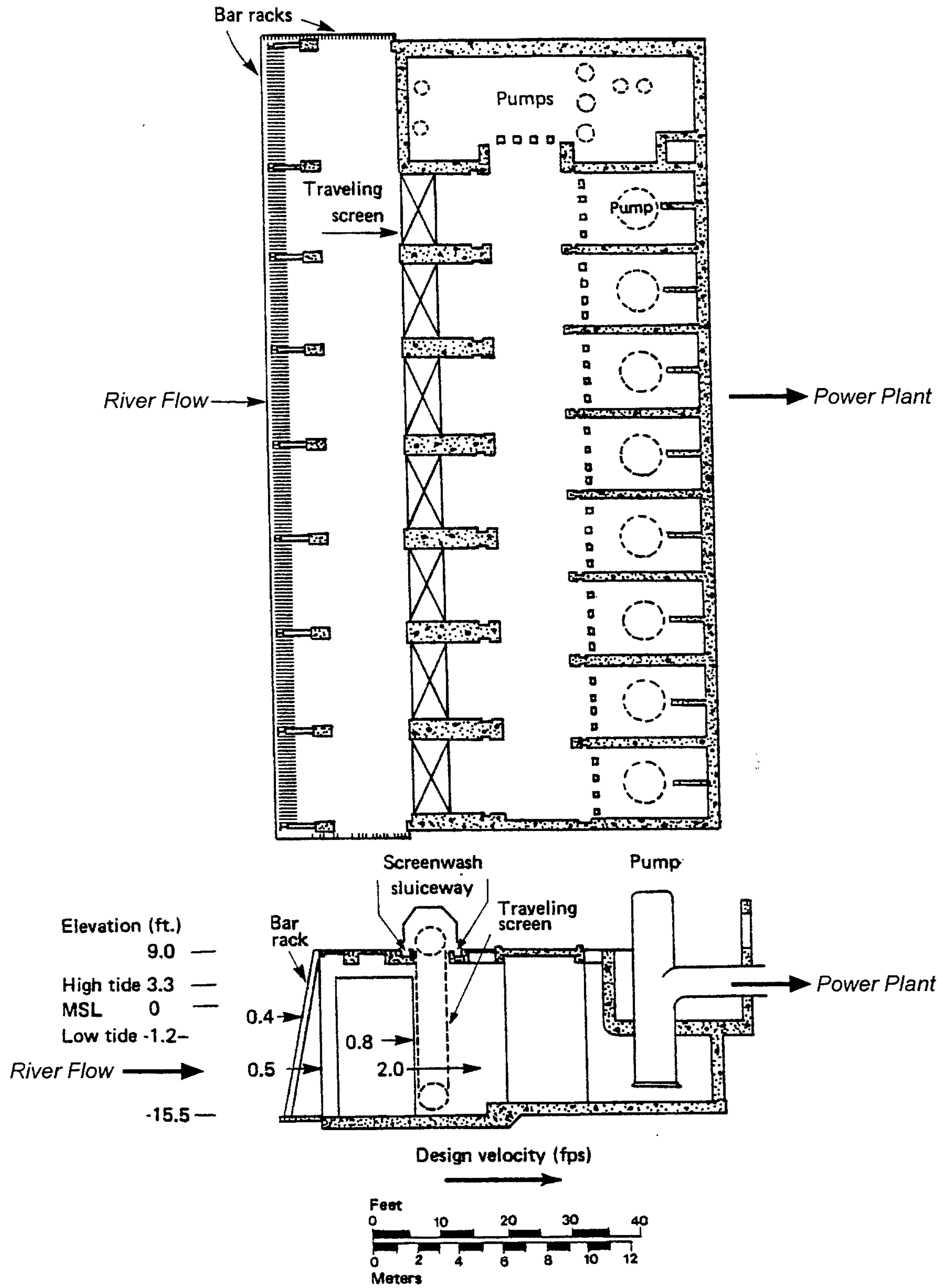

Figure 3-6. Plan and section schematic diagrams of Pittsburg Power Plant Units 1-4 intake structure.

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cfs) capacity. These centrifugal, vertical open impeller pumps are activated in sequence, as the wet well fills with screenwash, by three pedestal float switches set at different heights, and run until the well is empty. The pumps discharge into an 18-inch concrete pipe that empties into the Unit 5 discharge conduit.

During normal operation, for equipment safety and system reliability, each unit's two 49,300-gpm (110-cfs) circulating water pumps are run simultaneously and furnish 98,600 gpm (220 cfs) of cooling water to each of the four generating units. Single-pump operation occurs only during condenser maintenance inspections and pump outages. Under single-pump operation, electrical generation must be limited to less than 50% of the unit's maximum capacity. The combined circulating water flow of Units 1-4 in normal operation is 394,000 gpm (880 cfs). These pumps were retrofitted with variable speed discharge (VSD) controls in 1988, allowing them to be operated from 70% to 95% of their rated capacity. VSDs allow the pumps to be operated at minimum speed/flow under minimum generation (~30-35 MW), increasing proportionately to 95% of speed/flow at ~45-60 MW. Between ~45-60 MW and maximum generation, 170 MW, the pumps must be placed in "by-pass" mode, allowing 100% of pump speed/flow.

In addition to the eight circulating water pumps, there are six 4,500-gpm (10-cfs) service water pumps that supply water to the Units 1-4 auxiliary cooling water heat exchangers from the Units 1-4 intake structure after the traveling screens. In normal operation, four of the six pumps are run to provide 18,000 gpm (39.8 cfs) of service water to the four generating units.

This volume constitutes less than 5% of the Units 1-4 cooling water flow. Cooling water is under pressure from the outlets of the circulating water pumps to the discharge. The pressure increases from atmospheric (about 14.7 psi) at the intake to 26.4 psi at the circulating water pump discharge. Pressure drops through the cooling water system, with about a 5-psi drop across the condenser. Relative pressures do not change during various tidal stages. The design delta-T, the rise in water temperature across the condenser, is 15.6° F in normal full-load operation.

A chlorine product is injected into the cooling system just ahead of the circulating water pumps to prevent condenser biofouling. For Units 1-4, each intake tunnel has a chlorine injection diffuser located ahead of the circulating water pump. Injection into the eight tunnels is controlled by automatic timers that chlorinate tunnels 1-8 in sequence, so that only one tunnel at a time is chlorinated. Chlorination is done for 30 minutes on a frequency that varies with season and need (determined by inspection). The usual schedule is one to three times a week; the maximum is once a day. A chlorine residual of 0.2-0.5 mg/l is maintained at the condenser inlet, and the total residual chlorine limit for the effluent discharge is 0.00 mg/l, as specified in the 1995 NPDES discharge permit.

3-2.3.2 Units 5 and 6 Circulating Cooling Water System

The circulating cooling water system serving Units 5 and 6 is depicted in Figure 3-4 and is shown schematically in Figure 3-5. The intake structure, adjacent to the Units 1-4 intake structure, also consists of bar racks, traveling screens, and circulating water pumps. Separate intake conduits conduct cooling water to the Units 5 and 6 condenser halves. The circulating water from the two condenser halves recombine at the condenser outlet. This flow remains separate from the other unit discharges through transit and discharge into the bay from a submerged outfall adjacent to that of Units 1-4. Circulating water system design specifications are presented in Table 3-4. Figure 3-7 shows the major features of the intake structure.

Bar racks spaced 4 inches on center are located about 15 ft in front of the vertical traveling screens. Vertical traveling screens with a mesh size of 3/8 inches retain smaller objects. Debris, along with fish and invertebrates retained by the screens, is removed during screen rotation and washing, which is initiated either by a timer, at about 4-hour intervals under normal operating conditions, or when the across-screen hydraulic differential exceeds a predetermined maximum.

During screen washing, high-pressure (110-psi) spray nozzles wash debris and impinged organisms into a surrounding sluiceway that empties into a screenwash wet well, which also receives the screenwash from the Units 1-4 traveling screens. The screenwash discharge is returned to the bay by three large-diameter trash pumps of 2,800 gpm (6 cfs) capacity. These centrifugal, vertical open impeller pumps are activated in sequence, as the wet well fills with screenwash, by three pedestal float switches set at different heights, and run until the well is empty. The pumps discharge into an 18-inch concrete pipe that empties into the Unit 5 discharge conduit.

During normal operation, for equipment safety and system reliability, each unit's two 80,250-gpm (178-cfs) circulating water pumps are run simultaneously and furnish 321,000 gpm (712 cfs) of circulating water to the Units 5 and 6 condensers. Single-pump operation at a unit only occurs during condenser maintenance inspections and pump outages. In single-pump operation, electrical generation from the unit is limited to less than 50% of its maximum capacity. These pumps were retrofitted with VSD controls in 1988, allowing them to be operated from 50% to 95% of their rated capacity. VSDs allow the pumps to be operated at minimum speed/flow under minimum generation (~25-40 MW), increasing proportionately to 95% of speed/flow at ~90-140 MW. Between ~90-140 MW and maximum generation, 330 MW, the pumps must be placed in "by-pass" mode, allowing 100% of pump speed/flow.

A portion of the circulating water is drawn from the circulating pump discharge ahead of the condensers for use in closed-cycle auxiliary circulating water heat exchangers. This water is discharged to the individual unit circulating water discharge conduits after the condensers.

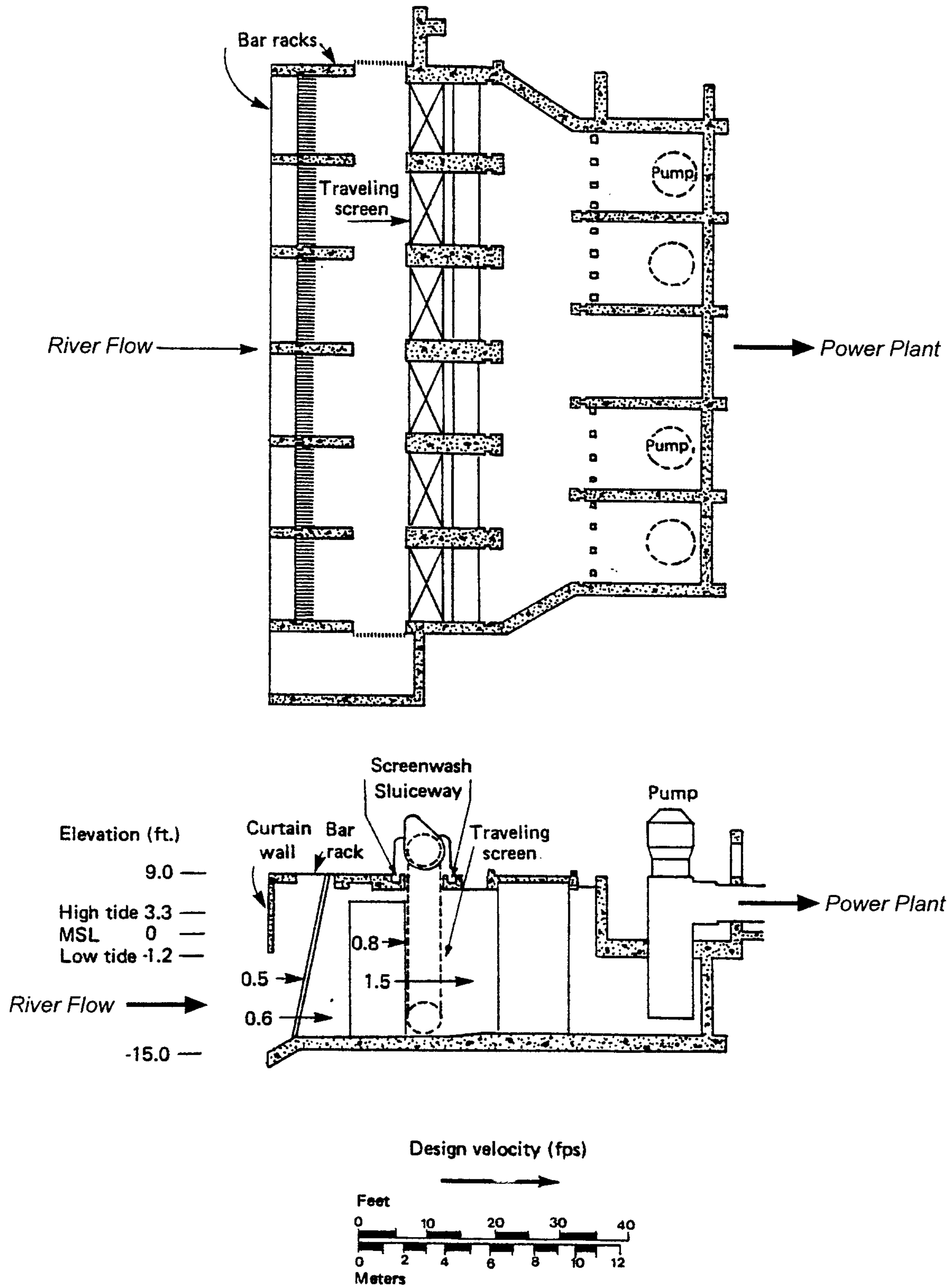

Figure 3-7. Plan and section schematic diagrams of Pittsburg Power Plant Units 5 & 6 intake structure.

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Circulating water is under pressure from the outlets of the circulating water pumps to the discharge structure. Pressure increases from atmospheric at the intake to 23.8 psi at the circulating water pump discharge. Pressure drops through the cooling system, with a 5.8-psi drop across the condenser. Relative pressures do not change during various tidal stages. The design delta-T is 17.3°F under normal full-load operation.

A chlorine product is injected into the circulating water system just ahead of the circulating water pumps to prevent condenser biofouling. For the four tunnels of Units 5 and 6, injection is controlled by automatic timers that chlorinate tunnels 9-12 in sequence following the chlorination of the Units 1-4 tunnels. Chlorination times, frequencies, and residuals are the same as for Units 1-4. Chlorination is done for 30 minutes on a frequency that varies with season and need (determined by inspection). The usual schedule is one to three times a week; the maximum is once a day. A chlorine residual of 0.2-0.5 mg/l is maintained at the condenser inlet, and the total residual chlorine limit for the effluent discharge is 0.00 mg/l, as specified in the 1995 NPDES discharge permit.

3-2.3.2 Unit 7 Circulating Cooling Water System

The closed cooling water system for Unit 7 is depicted in Figure 3-4 and shown schematically in Figure 3-5. This closed-cycle system uses mechanical-draft, wet cooling towers to dissipate the heat transferred to the circulating cooling water flow during transit through the condensers. In a closed-cycle system, "makeup" water is withdrawn from a source to replace that evaporated in the cooling towers or carried away in small droplets (drift) and to control the dissolved solids content of the cooling water. The portion returned to the water body with its higher concentration of minerals is called blowdown. The ratio of the water returned (blowdown) to water withdrawn (makeup) depends on a number of factors affecting the rate of evaporation, including air temperature, humidity, and wind.

Unit 7 makeup water is withdrawn from behind the Units 1-4 intake structure by three 10,100-gpm (22.5-cfs) makeup water pumps. In normal operation, two of the pumps are run simultaneously and furnish 45 cfs of makeup water to the cooling system. Maximum losses from drift and evaporation have been estimated at about 7,000 gpm (15.6 cfs). Blowdown flow is discharged through a manifold tem, which distributes it into the discharge conduits of the once-through units (Figure 3-5). Because the makeup water pumps run continuously, the blowdown flow varies with unit operation, from a minimum of 29.4 cfs during periods of maximum evaporation to nearly the full makeup water flow when the generating load is low.

Chlorine is injected into the circulating water flow to prevent condenser biofouling. Unit 7 is generally chlorinated for 10 minutes twice a day to maintain a 0.5-mg/l chlorine residual at the condenser inlet water box. Chlorination frequency varies with season and need (determined by inspection). No detectable chlorine residual remains in the blowdown flow.

3-2.4 Operation Impacts

The Pittsburg Power Plant HCP boundary area falls within the designated critical habitat for four of the listed species, winter-run salmon, spring-run salmon, Delta smelt, and Sacramento splittail. A variety of investigations at the Pittsburg Power Plant have been conducted to characterize fish losses resulting from circulating water system operations, and to identify and implement measures to minimize these losses. Operation of the power plant's circulating water system has the potential for impacting aquatic organisms through entrainment, impingement, and exposure to elevated water temperatures within the thermal discharge plume. Entrainment impacts consists of those organisms that go through the circulating water system; impingement impacts consists of those organisms that are held against the intake screen; and thermal impacts consists of those organisms that are affected by the heated discharge of the circulating water after it leaves the power plant. Various past studies have documented the range of potential impacts from the plants' circulating water system for the species listed in the HCP. Each of these potential impacts are more fully described below. Aquatic monitoring programs that have addressed these issues in the past are discussed in detail in Appendix B.

If the AFB is demonstrated effective at the Contra Costa Power Plant during Phase I, it will subsequently be implemented during Phase II at the Pittsburg Power Plant. An intensive biological monitoring program will be conducted to determine whether the AFB is effective at the plant. SE expects that if the AFB is effective, impacts to sensitive aquatic species should be reduced by approximately 80-99 percent. Even with a number of physical constraints not present at the Pittsburg Power Plant, such technology was estimated to result in an 80 percent reduction in entrainable organisms at the Lovett Generating Station on the Hudson River in New York. (Applied Science Associates 1999). AFB approach velocities are designed at 0.02 ft/sec., and impingement of sensitive aquatic organisms at this approach velocity are expected to be negligible. Further, the AFB would require the enclosure of some twenty-eight acres of the Delta area. Approximately 17 acres of this enclosed area would comprise shallow water habitat. This impact, would, however, be mitigated by the creation of shallow and open water habitat during Phase III. If AFB technology is not effective at the Pittsburg Power Plant, it could be removed without permanent loss of shallow water habitat that would ordinarily accrue with other screen technology.

3-2.4.1 Entrainment

Entrainment is the hydraulic capture and subsequent passage of organisms through the circulating water system. The organisms involved are small (typically, less than 20 mm long), unable to avoid the extant screens, and capable of passing through the 3/8-inch mesh of the intake screens and include eggs, larvae, and early juvenile stages of various fish species. As these entrained organisms pass through the circulating water system, they can be exposed to several types of stresses. These include mechanical, pressure, shear, thermal, and chemical stresses. The potential impact of entrainment is a function of the number of organisms that do not survive passage through the circulating water system. These screens would remain in place during the implementation of Phase I.

Based on results of entrainment monitoring (Clean Water Act Section 316[b] studies) conducted in 1978 and 1979 (Ecological Analysts, Inc. 1981a), estimates of the numbers of larval fish and eggs entrained annually at Pittsburg Power Plant were calculated based on actual circulating water system operations. The estimates of entrained larval Delta smelt, longfin smelt, Osmeridae (members of the smelt family not identified to species), Sacramento splittail, chinook salmon, and green sturgeon for March 1978-March 1979 are summarized in Table 3-5. The estimates provided in Table 3-5 are from a monthly sampling program conducted over a 1-year study period, and represent entrainment levels at design flow for that year based on each month's density values. Entrainment survival can vary between 0 and 80% and is dependent on species, life stage, and cooling water temperature (Ecological Analysts, Inc. 1981a). However, because future operating conditions at the power plant are unknown, it is not possible to accurately predict survival rates on organisms entrained through the power plant.

Because most of the species listed in Table 3-5 have experienced significant declines in their populations over the past 20 or more years, a potential current entrainment column has also been included. The adjustment factors used to develop potential current entrainment estimates are based either on information from the U.S. Federal Register or from the **Sacramento/San Joaquin Delta Native Fishes Recovery Plan** (USFWS, 1996). Adjustment factors are presented for Delta smelt, longfin smelt, Osmeridae, and splittail because specific declines in their population abundances were available from published literature. Current potential entrainment estimates for fall/late fall-run chinook salmon were not calculated because this population is believed to be at or near its historical level (Federal Register Vol. 63, No. 45/ Monday, March 9, 1998). No adjustment factors are presented for the other species listed because none of them were collected during the 1978-1979 entrainment studies and therefore no annual entrainment estimates were generated.

The USFWS (Federal Register Volume 58, No. 49/Tuesday, March 16, 1993) estimated that the entire Delta smelt population experienced nearly a 90 percent decline in the 20-year period prior to the species' listing in 1993. The summer townet surveys conducted by CDFG also show a general decrease over the same time period. This index for Delta smelt peaked at 65.2 in 1978, the year that most of the information on Delta smelt estimated entrainment is based; declined to 0.8 in 1982, and for all but 2 years since 1982 has been below 10. The estimated 1978-1979 annual entrainment estimates presented in Table 3-5, therefore, potentially overestimate potential current entrainment by approximately a factor of 10. Using this correction factor, the potential current entrainment estimates at full design flow of the circulating water system may be closer to 46,000 Delta smelt than the historical estimate of 455,413.

Table 3-5. Total Number of Fish Collected during Entrainment Sampling, Estimated Annual Entrainment at Pittsburg Power Plant for March 1978 - March 1979, and Potential Current Entrainment at Full Design Flow of Circulating Water Volumes [1]

FISH SPECIES ENTRAINED	Number of fish collected[2]	1978-1979 Entrainment[3]	Reduction Factor	Potential Current Entrainment[4]
Delta smelt[5]	46	455,413 ± 184,516	90%[6]	46,000
Longfin smelt[7]	13	190,229 ± 198,009	90%[8]	19,000
Osmeridae[9]	2,278	64,784,071 ± 29,475,225	90%[10]	6,500,000
Sacramento splittail	16	155,289 ± 60,064	62%[11]	59,000
Winter-run chinook salmon	0	0	None	0
Spring-run chinook salmon	0	0	None	0
Fall/late fall-run chinook salmon	2	23,598 ± 35,468	None[12]	23,598 ± 35,468
Steelhead	0	0	None	0
Green sturgeon	0	0	None	0

1 Assumes that AFB is not in place; if AFB is in place and operates as expected, potential entrainment should be reduced by 80-99 percent.
2 Represents total number of fish collected during study period.
3 Estimates based on entrainment densities (March-December 1978, and from January-March 1979) and include 95% confidence interval.
4 Estimates represent maximum potential based on design flow; actual flows are less.
5 Delta smelt collected ranged in length from 15 to 34 mm.
6 Federal Register Volume 58, No. 49/ Tuesday, March 16, 1993.
7 Longfin smelt collected ranged in length from 24 to 68 mm.
8 **Sacramento/San Joaquin Delta Native Fishes Recovery Plan**, USFWS, 1996.
9 Osmeridae collected ranged in length from 3 to 22 mm. Because most of the Osmeridae were collected in January and February, which is generally early for Delta smelt, and coupled with the high number of longfin smelt collected relative to Delta smelt in the impingement studies, suggests that most of these larvae were probably longfin smelt.
10 Average of reductions for Delta smelt and longfin smelt.
11 Federal Register Volume 64, No. 25/Monday, February 8, 1999.
12 This run was reported in the Federal Register Volume 63, No. 45/Monday, March 9, 1998 to be at or near historical levels, consequently, no reduction factor is necessary.

Like Delta smelt, longfin smelt have also experienced an estimated 90% decline in their abundances in the Sacramento-San Joaquin estuary, between 1984 and 1992 (Meng 1993 in USFWS 1996). Longfin smelt were once one of the most abundant fish in the estuary until the early 1980s and were consistently caught in large numbers by the CDFG FMWT index survey of the upper estuary, the CDFG otter trawl and midwater trawl Bay survey, and the UCD Suisun Marsh surveys (Herbold et al. 1992 in USFWS 1996). This period of consistent abundance for longfin smelt is also consistent with the 1978-1979 316(b) studies on which the estimated entrainment for longfin smelt shown in Table 3-5 is based. The estimated number of longfin smelt shown in this table may be potentially overestimated by a factor of 10, as was Delta smelt. Using this correction factor, the potential current annual entrainment estimate at full design flow of the circulating water system may be closer to 19,000 longfin smelt than the historical estimate of 190,229.

The adjustment factor for Osmeridae, those smelt too small to be identified as either Delta or longfin smelt, was calculated simply by using the same adjustment factor, 10, that was common to both of these species, as described in the paragraphs above. Consequently, the potential current entrainment estimate for Osmeridae at full design flow of the circulating water system may be closer to 6.5 million than the historical estimate of 64,784,071.

Sacramento splittail have disappeared from much of their native range and their principle habitat is now limited to the Sacramento-San Joaquin estuary, especially the Delta (USFWS 1996). Within this range, the splittail population has been estimated to be 35% to 60% as abundant as they were in 1940 (CDFG 1992b in USFWS 1996), and the USFWS (Fed. Reg. Vol. 64, No. 25/ Monday, February 8, 1999) reported that they have declined by 62% over the last 15 years. As with both Delta and longfin smelt, discussed above, the decline in splittail abundance occurred after the 1978-1979 studies on which Table 3-5 is based. Thus, the estimated 1978-1979 entrainment presented in this table potentially overestimates current entrainment by a factor of approximately 2.5. Using this correction factor, the annual current potential entrainment estimate at full design flow of the circulating water system may be closer to 59,000 than the historical estimate of 155,289.

It needs to be also clearly understood that the estimates presented in Table 3-5 are based on full design flow of the cooling water system of the power plant and do not represent actual 1978-1979 flows or current actual flows, both of which are less. Due to required maintenance measures, at a minimum, it would be impossible to operate the Pittsburg Power Plant at full design flow over the course of a year. The power plant is operated based on demand, which varies seasonally and annually as a function of Bay Area electrical load needs, availability of out-of-area generation, transmission line capacity factors, and what must be generated locally. Actual monthly cooling water flows for February through July (the proposed flow minimization period, see Section 4) for the years 1986 to 1999 are presented in Table E-2 in Appendix E. This data is graphically illustrated in Figure E-1 of Appendix E and shows that circulating water flows were 80% or less of full design flow 88% of the time. As Table E-2 shows, the average monthly flows for the Pittsburg Power Plant varied between 32% and 57% of design flow, with specific actual monthly flows ranging from 9% (May 1998) to 97% (March 1988). Using average monthly flow values, the adjusted potential current entrainment estimates discussed above could be further reduced by an additional 43-68% to more accurately reflect actual flow conditions rather than full 100% flow for the entire 6-month period (February 1-July 31).

As a consequence of the inability to taxonomically differentiate between larval longfin smelt and Delta smelt, results of entrainment monitoring performed during these studies were combined for these two species and reported in most cases only as smelt (*Osmeridae*). Because most of the Osmeridae were collected in January and February, which is generally early for Delta smelt, and coupled with the high number of longfin smelt collected relative to Delta smelt in the impingement studies (almost a ten-to-one ratio), suggests that most of these larvae were probably longfin smelt. The two chinook salmon collected were 39 and 41 mm in length and were both collected in March. Based on a chinook salmon length category table (Fisher (CDFG) unpublished, 1991) used during PG&E's 1995 Delta smelt monitoring program to differentiate between salmon of different run types, these two salmon were fall run fish. These estimates were based on a methodology that sampled less than 0.006% of the volume of water diverted through the plant during the term of the study.

More recently, as part of a program to reduce striped bass entrainment losses, striped bass entrainment monitoring was performed at Pittsburg Power Plant from 1986 through 1992. Each year, entrainment monitoring commenced May 1 and typically continued to mid-July. Delta smelt, longfin smelt, Sacramento splittail, chinook salmon, steelhead, and green sturgeon collected in these entrainment samples over the 7-year period and the estimated average May-July entrainment based on the density that those numbers represented are summarized in Table 3-6. During the early period of this entrainment monitoring program (1986-1989), larval Delta smelt and longfin smelt could not be taxonomically differentiated with confidence and, therefore, results of these collections have been combined for these two species and recorded as Osmeridae. Beginning in 1990, taxonomic identification of larval Delta smelt and longfin smelt improved, and the two species were recorded separately. This table was not adjusted because most, if not all, of the population declines for the listed species had already occurred prior to the study period this table was based on.

Table 3-6. Total Number of Fish Collected during the 1986-1992 Sampling Period and the Estimated Average May-July Entrainment at the Pittsburg Power Plant[1]

FISH SPECIES ENTRAINED	Number of fish collected from 1986-1992[2]	Estimated average May-July entrainment[3]
Delta smelt	4	12,924 ± 12,661
Longfin smelt	18	58,160 ± 33,463
Osmeridae	126	407,122 ± 347,135
Sacramento splittail	26	84,009 ± 36,833
Winter-run chinook salmon	0	0
Spring-run chinook salmon	0	0
Fall/late fall-run chinook salmon	0	0
Steelhead	0	0
Green sturgeon	0	0

[1] Data collected from May 1 - about July 15 each year.
[2] Represents total number of fish collected during the 7-year study period.
[3] Estimated entrainment based on design flow for the May-July sampling period, and includes 95% confidence interval.

Table 3-7 presents the number collected and estimated entrainment by year for Delta smelt, longfin smelt, Osmeridae, and Sacramento splittail sampled between 1986-1992. Entrainment estimates are for the months of May-July only, and were calculated by using the striped bass simulation model (SIMBAS). This computer program uses species specific sampling densities (collected as part of the striped bass monitoring program described in Section 3-2.5) and actual circulating water volumes to calculate entrainment estimates. As this table indicates, with the exception of 1986 and 1987, generally very few fish (0-9) were collected during each year's 3-month sampling effort. Although specific length measurements were not taken for these species during the study period, all fish were originally classified as either larvae (up to 15-20 mm long, depending on species) or juveniles (generally 16-20 mm or longer in length). As this table shows, 85 % (126) of the 148 osmerids (Delta smelt, longfin smelt, and Osmeridae combined) collected and 88 % of the total entrainment estimate for the 7-year long study were classified as larvae.

The significance of these entrainment loss estimates on populations of Delta smelt, longfin smelt, Sacramento splittail, chinook salmon, and green sturgeon inhabiting the Bay/Delta system is difficult to assess due to the low numbers of these species that were collected, the large volumes of water over which the densities were extrapolated to estimate entrainment totals, age of the data, the large variances associated with entrainment estimates, the limited seasonal timing of the 1986-1992 sampling efforts, and the population declines which have occurred since the 1978-1979 sampling effort was conducted. SE has expressed take in the form of acre-feet of water, as suggested by the HCP handbook (USFWS/NMFS 1996), when the specific number of individuals is unknown or is indeterminable.

As noted elsewhere, if the AFB is demonstrated effective at the Contra Costa Power Plant during Phase I, it would be implemented at the Pittsburg Power Plant during Phase II. The potential

Table 3-7. Number of fish collected and Estimated May-July Entrainment by Year during the 1986-1992 Sampling Period[1] at the Pittsburg Power Plant as calculated by the SIMBAS[2] Model

		Species							
		Delta smelt		Longfin smelt		Osmeridae		Sacramento splittail	
Year	No. Collected/ Est. Entrainment	Larvae[3]	Juvenile[4]	Larvae[5]	Juvenile[6]	Larvae[7]	Juvenile[8]	Larvae[3]	Juvenile[4]
1992	No. Collected	1	0	0	2	0	0	0	0
	Est. Entrainment	9,579	0	0	12,595	0	0	0	0
1991	No. Collected	0	0	0	3	0	0	0	6
	Est. Entrainment	0	0	0	44,353	0	0	0	39,314
1990	No. Collected	0	2	2	0	0	0	0	0
	Est. Entrainment	0	25,184	35,075	0	0	0	0	0
1989	No. Collected	0	0	6	2	9	0	0	5
	Est. Entrainment	0	0	42,817	5,511	119,849	0	0	42,578
1988	No. Collected	0	1	1	2	1	3	0	3
	Est. Entrainment	0	5,064	44,093	12,899	74,822	48,009	0	48,602
1987	No. Collected	0	0	0	0	82	3	0	0
	Est. Entrainment	0	0	0	0	1,107,739	29,367	0	0
1986	No. Collected	0	0	0	0	24	4	0	12
	Est. Entrainment	0	0	0	0	63,634	12,475	0	38,596
	Total Collected	1	3	9	9	116	10	0	26
	Total Entrained	9,579	30,248	121,985	75,358	1,366,044	89,851	0	169,090

[1] Data collected from May 1 - approximately mid-July.

[2] The SIMBAS Model was originally developed as part of the striped bass monitoring program and uses actual fish density data and circulating water volume data to determine entrainment estimates.

[3] Delta smelt and splittail were classified as larvae up to ~15 mm long.

[4] Delta smelt and splittail were classified as juveniles starting at ~ 16 mm long.

[5] Longfin smelt were classified as larvae up to ~ 20 mm long .

[6] Longfin smelt were classified as juveniles starting at ~ 21 mm.

[7] Osmerids were classified as larvae up to ~15-20 mm long.

[8] Osmerids were classified as juveniles starting at ~ 15-20 mm long.

impacts set forth in Tables 3-5 and 3-6, are expected to be reduced by eighty to ninety percent. If, however, the AFB is not demonstrated effective during Phase I, such technology would not be deployed at the Pittsburg Power Plant during Phase II.

Sensitive Fish Species Monitoring.

For VSD Flow Minimization, the abundance of the eight sensitive fish species identified in this HCP will be documented during on-site entrainment studies to be conducted at the Pittsburg Power Plant. The entrainment monitoring will be done annually from May through mid-July in conjunction with a striped bass monitoring program conducted under the jurisdiction of the CDFG. Because sensitive species monitoring will occur concurrently with the existing striped bass monitoring program, the additional take of listed species will be minimized. Both USFWS and CDFG have expressed concern that other current Delta smelt monitoring programs may already be taking too many fish and that it is unlikely that any additional monitoring will be permitted.

The specifics of the sampling program are provided in Section 3-2.5. Results from this monitoring related to the sensitive fish species will be used to verify the take of these species in entrainment samples collected during the May-July time period. The following threshold and reporting standards are established for VSD.

A. Threshold—VSD

Sensitive fish species will be sampled using standard ichthyoplankton nets at both of the power plant discharge sites, and data will be reported as total number collected during the sampling period and as catch/unit effort. The take of sensitive species during this monitoring effort is expected to be minimal based on previous years' results, primarily because of the small volume of water sampled each year (0.006 % of flow through the plant), and the low abundance of the sensitive species. The results of these sampling efforts will be used to improve the understanding of the plants impacts and to provide information for future refinement of minimization measures.

The following take limit threshold will apply for the only species currently with endangered status (winter-run chinook salmon). No winter-run chinook salmon are expected to be collected during this effort. If a winter-run salmon is collected, the sampling will be discontinued and USFWS, NMFS and CDFG will be notified immediately. The agencies may allow sampling to resume following notification. The specifics of the monitoring program are described in detail in Section 3-2.5.

B. Reporting—VSD

Monitoring data on the sensitive fish species collected during the entrainment sampling will be submitted in an annual report by January 31.

If the AFB is not ef :tive at Contra Costa Power Plant in Phase I, then the sampling program will remain the same as set forth above. However, if the AFB is deployed at the Pittsburg Power Plant, the abundance of the eight sensitive fish species identified in this HCP will be documented during a limited time (up to three years unless extended by mutual agreement of SE, NMFS, USFWS, and CDFG), intensive on-site entrainment study in accordance with a biological monitoring and sampling program as set forth in Appendix H. The entrainment monitoring will be performed from February through July.

Results from this monitoring related to the sensitive fish species will be used to determine the efficacy of the AFB technology in preventing entrainment of HCP species. Sampling will be conducted as set forth both inside and outside the AFB. The biological sampling program may be refined in consultation with a technical team comprised of representatives of the USFWS, NMFS, and CDFG. Should the AFB be determined effective, it is expected that sampling will be reduced in order to lessen the take and impact to sensitive species. The following threshold and reporting standards will be followed for AFB.

C. Threshold—AFB

Sensitive fish species will be sampled using standard ichthyoplankton nets at both of the power plant discharge sites and by push nets, and data will be reported as total number collected during the sampling period and as catch/unit effort. The take of sensitive species during this monitoring effort is expected to be minimal based on previous years' results, primarily because of the small volume of water sampled and the low abundance of the sensitive species. The results of these sampling efforts will be used to improve the understanding of the effectiveness of the AFB under various conditions and the plant's impacts and to provide information for future refinement of minimization measures.

The following take limit threshold will apply for the only species currently with endangered status (winter-run chinook salmon). No winter-run chinook salmon are expected to be collected during this effort. If a winter-run salmon is collected, the USFWS, NMFS and CDFG will be notified immediately to determine an appropriate course of action. Depending on the outcome of consultation with the agencies, sampling may resume under the same conditions, modified, or discontinued. The specifics of the monitoring program are described in detail in Section 3-2.5.

D. Reporting—AFB

Monitoring data on the sensitive fish species collected during the entrainment sampling will be submitted in an annual report by January 31.

3-2.4.2 Impingement

Impingement occurs when an organism is held against the intake screens used to remove debris from the circulating water. Fish susceptible to impingement are typically either small juveniles (typically greater than 38 mm long) or large juveniles and adults that are in a weakened condition or have died from other causes. The percentage survival of impinged fish depends on the species, life stage, and size of the organism. Other factors influencing impingement survival include the duration of impingement and the techniques of handling impinged organisms and returning them to the water body, as well as seasonal water body characteristics, such as salinity, water temperature, etc. For the purposes of this document, it is assumed that no impinged organisms survive to be returned to the receiving waters.

The results of power plant studies conducted in 1978 and 1979 (Ecological Analysts, Inc. 1981a) provide estimates of Delta smelt, longfin smelt, Sacramento splittail, chinook salmon, steelhead, and green sturgeon impinged at the circulating water intake structures at Pittsburg Power Plant (Table 3-8). Unlike entrainment monitoring where a relatively small volume of circulating water is sampled, impingement samples reflect the total volume of circulating water for each collection effort. To estimate the design flow values for Delta smelt and the unidentified Osmeridae grouping, the impingement estimates given in Appendix E of the **"Cooling Water Intake Structure 316(b) Demonstration"** (Ecological Analysts, Inc. 1981a) for actual operations were multiplied by the ratio of impingement at design flow and actual operations for longfin smelt, which was provided in Appendix E. For chinook salmon, the actual operation values were multiplied by the ratio of impingement at design flow and actual operations for splittail, which was also provided in Appendix E.

Table 3-8. Total Number of Fish Collected during Impingement Sampling, Estimated Annual Impingement at Pittsburg Power Plant for March 1978-March 1979, and Potential Current Impingement at Full Design Flow of Circulating Water Volumes

FISH SPECIES IMPINGED	Number of fish collected[1]	1978-1979 Impingement[2]	Reduction Factor	Potential Current Impingement[3]
Delta smelt	1,490	14,082 ± 6,454	90%[4]	1,400
Longfin smelt	13,466	137,261 ± 55,576	90%[5]	13,700
Osmeridae	3	25 ± 29	90%[6]	3
Sacramento splittail	1,517	8,732 ± 4,596	62%[7]	3,300
Winter-run chinook salmon	57 of 141	323 of 808 ± 132	93%[8]	23
Spring-run chinook salmon	82 of 141	469 of 808 ± 192	None[9]	469 of 808 ± 192
Fall/late fall-run chinook salmon	136 of 141	776 of 808 ± 318	None[10]	776 of 808 ± 318
Steelhead	0	0	None	0
Green sturgeon	0	0	None	0

[1] Represents total number of fish collected during study period.
[2] Estimates based on impingement densities (March-December 1978 and from January-March 1979) and include 95% confidence interval.
[3] Estimates represent maximum potential based on design flow; actual flows are less.
[4] Federal Register Volume 58, No. 49/ Tuesday, March 16, 1993.
[5] **Sacramento/San Joaquin Delta Native Fishes Recovery Plan,** USFWS, 1996.
[6] Average of reductions for Delta smelt and longfin smelt.
[7] Federal Register Volume 64, No. 25/Monday, February 8, 1999.
[8] Reduction based on analysis presented in Section 3-2.9.2 of HCP; a reduction estimate of 99% between 1966 and 1991 was presented in **Recommendations for the Recovery of the Sacramento River Winter-Run Chinook Salmon**, March 9, 1996 by the Sacramento River Winter-Run Chinook Salmon Recovery Team.
[9] No adjustment values for this species could be found in the literature; therefore, it was left uncorrected.
[10] This run was reported in the Federal Register Volume 63, No. 45/Monday, March 9, 1998, to be at or near historical levels; consequently, no reduction factor is necessary.

Because most of the species listed in Table 3-8 have experienced significant declines in their populations over the past 20 or more years, a potential current impingement column has also been included. Adjustment factors presented for Delta smelt, longfin smelt, Osmeridae, and splittail were available from published literature and were fully described in the previous section, and the reduction factor for winter-run salmon is described later in this section. Current potential impingement estimates for fall/late fall-run chinook salmon were not calculated because this population is believed to be at or near its historical level (U.S. Fed. Reg. Vol. 63, No. 45/ Monday, March 9, 1998) and, although spring-run chinook salmon was listed as state threatened in February of 1999, no published reduction estimates could be found in the literature; consequently, no adjustment factor was available. No adjustment factors are presented for either steelhead or green sturgeon because neither of them were collected during the 1978-1979 entrainment studies and therefore no annual impingement estimates were generated.

Even though individual lengths of the chinook salmon collected during the 316(b) impingement studies are not available, monthly length ranges were recorded in Appendix E of the 316(b)

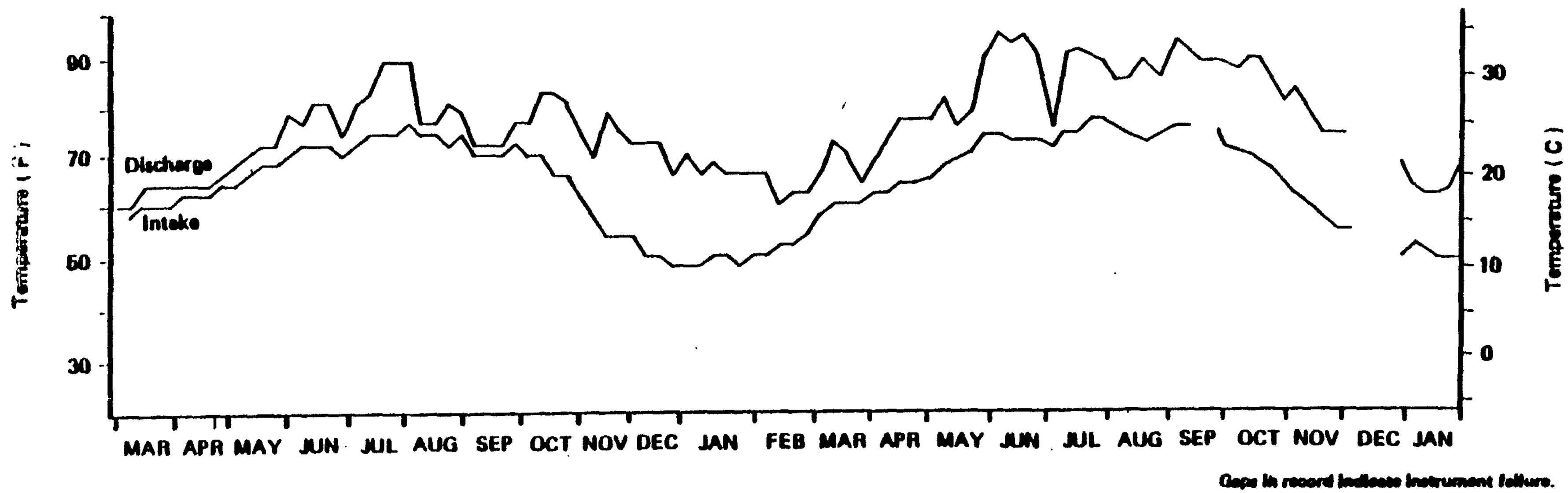


Figure 3-8. Average weekly intake and discharge temperatures at Contra Costa Power Plant Units 1-5 (March 1978-December 1979).

Demonstration (Ecological Analysts, Inc. 1981a). The monthly totals for the fish collected during the 1978-79 impingement sampling, and the categories for the different run types are shown in Table 3-9.

Table 3-9. Total and Maximum Number of Chinook Salmon Collected, by Run Categories[1], during Impingement Sampling at the Pittsburg Power Plant (March 1978-November 1979) based on Length and Month of Capture

MONTH/YEAR	Actual number collected	Maximum number collected by run category		
		Winter -run	Spring-run	Fall/late fall-run
MAR 78	0	-	-	-
APR 78	14	-	13	14
MAY 78	3	-	-	3
JUN 78	8	-	-	8
JUL 78	3	-	-	3
AUG 78	0	-	-	-
SEP 78	0	-	-	-
OCT 78	0	-	-	-
NOV 78	5	4	-	4
DEC 78	9	-	-	9
JAN 79	10	8	9	9
FEB 79	16	15	14	15
MAR 79	20	19	18	19
APR 79	12	11	11	11
MAY 79	18	-	17	18
JUN 79	13	-	-	13
JUL 79	10	-	-	10
AUG 79	0	-	-	-
SEP 79	0	-	-	-
OCT 79	0	-	-	-
NOV 79	0	-	-	-
TOTAL/MAX.	141	57	82	136
PERCENT		40%	58%	96%

[1] This table is based on Table B-4 of Appendix B. The number shown under each of the runs is the maximum number possible based on the analyses of Frank Fisher of CDFG (1991 unpublished data).

For winter-run, a maximum of 40% of the fish fall into the winter-run category. Therefore, worst-case impingement of winter-run based on 1978-79 abundances could have been 40% of 808, o 323 total fish. If the average of 1978 and 1979 adult winter-run counts (23,669 and 2,251 = 25,920) is compared with the average of the 1995 and 1996 winter-run counts (1,296 and 527 = 1,823), the predicted 1995 and 1996 annual impingement estimate would be 7% of the 1978-79 total, or 23 winter-run smolts. For the spring and fall/late fall runs, the worst-case impingement of the different run types in 1978-79 could have been 469 and 776 chinook salmon, respectively. The decreases in abundance between 1978-79 and 1995-96 for the spring and fall/late fall runs were less extreme than for winter-run, so the adjusted values were not calculated for the other runs. These worst-case estimates add up to a value greater than the total estimated number because an unknown percentage of these fish fall into more than one of the run categories.

Impingement monitoring was also performed at circulating water intakes from 1987 through 1990. In general, the impingement sampling was done once a month from August through February. The number of Osmeridae, Delta smelt, longfin smelt, Sacramento splittail, chinook salmon, steelhead, and green sturgeon collected in impingement samples during each of these periods is summarized in Table 3-10. Based on the estimates provided in Table 3-9, impingement of Delta smelt and chinook salmon during the August through February time period appear to be minimal.

Table 3-10. Total Number of Fish Collected during 1987-1990 Sampling Period and Estimated Average August-February Impingement at the Pittsburg Power Plant[1]

FISH SPECIES IMPINGED	Total number of fish collected from 1987-1990[2]	Estimated average August-February impingement[3]
Delta smelt	8	165 ± 585
Longfin smelt	359	7,395 ± 26,864
Osmeridae	0	0
Sacramento splittail	6	124 ± 299
Winter-run chinook salmon	0	0
Spring-run chinook salmon	0	0
Fall/late fall-run chinook salmon[4]	3	62 ± 302
Steelhead	0	0
Green sturgeon	0	0

1 Data collected from August 1 - February 28 each year.
2 Represents total number of fish collected during the 3-year study period.
3 Estimated impingement based on densities established in the August-February sampling and scaled linearly to design flow, and includes 95% confidence interval.
4 Two of these fish were 40 mm in length and were collected in January, and therefore were fall/late fall-run fish, not winter-run. The third specimen was a dead adult (610mm) in October that was either hit by boat prop or attacked by a sea lion.

The relative proportion of fish impinged to those entrained at Pittsburg Power Plant was very small, as illustrated by comparing Tables 3-8 and 3-10 to Tables 3-5 and 3-6, respectively. The total percentage of Osmerids (to simplify the analysis, all Delta smelt, longfin smelt and Osmeridae were combined because the vast majority of fish originally entrained could only be identified to Osmeridae) impinged compared to entrained in the 1978-79 studies was only 0.2% and for the 1986-92 entrainment/1987-90 impingement studies was 1.6%. The percentage of Sacramento splittail impinged compared to entrained in the 1978-79 studies was 5.6% and in the 1986-92 entrainment/1987-90 impingement studies was only 1.6%. No winter-run or spring-run chinook salmon were collected in either the 1978-79 and 1986-92 entrainment studies or the 1987-90 impingement study, but the estimated annual numbers of winter-run and spring-run impinged were 323 and 469, respectively, in the 1978-79 study. Because the populations of many Delta species have changed since these data were originally collected, the percentages presented above may not reflect current conditions.

3-2.4.3 Thermal Effects

Potential effects associated with exposure to power plant thermal discharge plumes include behavioral avoidance of potential habitat, behavioral attraction, increased susceptibility to predation from sublethal stress, reduced health and fitness, and potential acute mortality as a consequence of exposure to elevated temperatures. The response of a fish species to the thermal discharge plume varies depending on the thermal tolerance and physiology of the species, its life stage, acclimation temperature, the duration of exposure, the difference in temperatures between the acclimation temperature and the exposure temperature (delta-T), and the absolute temperature to which the organisms are exposed. Factors such as the geographic distribution of the thermal plume, the vertical distribution of the plume within the water column, mixing characteristics, the thermal dissipation (temperature decay), and the configuration and characteristics of discharge are important factors affecting the potential biological significance of exposure to the discharge.

In 1990, the Regional Water Quality Control Board, CDFG, and NMFS required PG&E to conduct a study of thermal effects on fisheries found in the vicinity of the power plant. A thermal effects assessment was conducted in 1992 (PG&E 1992). The assessment consisted of intensive water temperature monitoring of the cooling water discharge and receiving waters coupled with monthly fisheries surveys at locations in and out of the discharge plume. The study addressed general fish use in the vicinity of the discharges, direct mortality of fish and macroinvertebrates, fish condition (i.e., striped bass length/weight analysis), abnormalities and infection, susceptibility to predation, behavioral attraction and avoidance, and migration blockage. In addition, the assessment specifically addressed species of special interest, which included delta smelt, longfin smelt, Sacramento splittail, and juvenile chinook salmon. These special interest species are the major target fish species of the HCP. The results of the study showed that the discharge had no adverse impact on any of the anadromous fish or other aquatic species (including the HCP target species) inhabiting the area, and that beneficial uses were protected.

In addition, in 1995, as described in the Waste Discharge Requirements Order No. 95-225 issued to the Pittsburg Power Plant, the Regional Water Quality Control Board found the thermal effluent discharge limitations adequate to ensure protection of the beneficial uses of the receiving water.

No significant differences in thermal effects are expected to result if AFB technology is deployed during Phase II. The recirculation of the heated plume into the cooling water intake may be reduced and the plume may be directed farther out into the river when the river is flowing westward due to the AFB's presence.

3-2.4.4 Impact Summary and Comparison

As described in the three previous subsections, operation of the power plants circulating water system has the potential to impact aquatic organisms of the Delta through entrainment, impingement, and exposure to elevated water temperatures within the thermal discharge plume. Based on the 1978-1979 316(b) studies (Ecological Analysts Inc. 1981a), entrainment accounted for 99.8% of the total combined number of fish estimated to be entrained and impinged on an annual basis (at design flow). The most recent thermal effects studies conducted in 1991-1992 (PG&E 1992) concluded that the discharge had no adverse impacts on any of the target aquatic species covered by this HCP. Based on these results, it was concluded that the potential entrainment of aquatic organisms is the single most important impact of the operation of the power plants circulating water system.

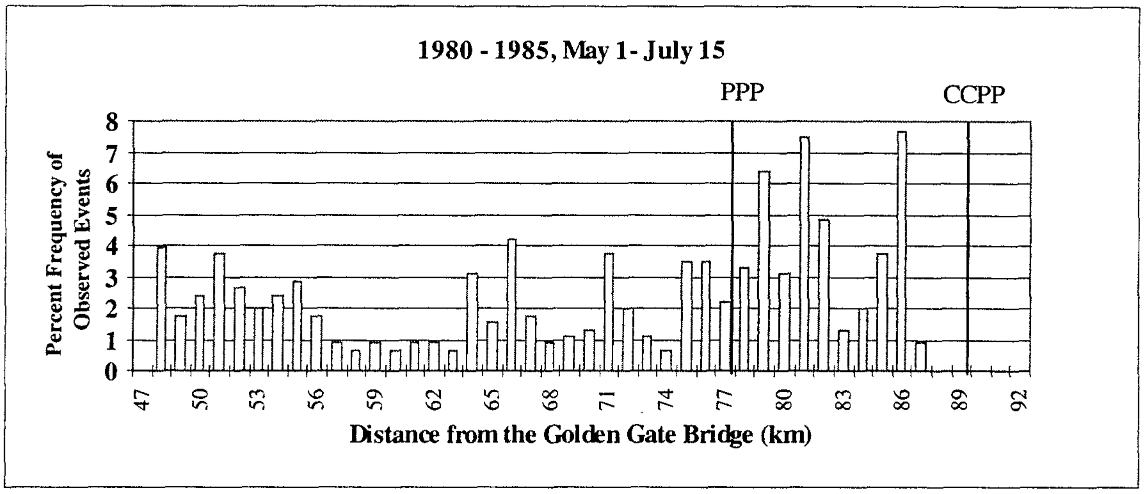
Entrainment is directly affected by the density of the aquatic organisms in the water being drawn into the power plant and the degree to which the power plant is operated. The 1978-1979 entrainment studies were conducted when most of the target species were much more abundant than they are now. Populations of some of these species, such as Sacramento splittail, Delta smelt, and longfin smelt have decreased by about 60 to 90% since these studies were originally conducted (see Section 3-2.4.1). The second factor in determining entrainment levels is how much circulating water is being used by the power plant. Although it is not possible to predict future powerplant operations, historical average monthly flows for February through July 1986-1999, varied between 32 to 57% and averaged 48% of the power plant design level (Appendix E, Table E-2). Predicting current potential entrainment estimates using a combination of reduced population estimates and average historical flow levels would result in almost an additional 50% decrease in the potential current entrainment amounts than shown in Table 3-5 for Sacramento splittail, Delta smelt, and longfin smelt.

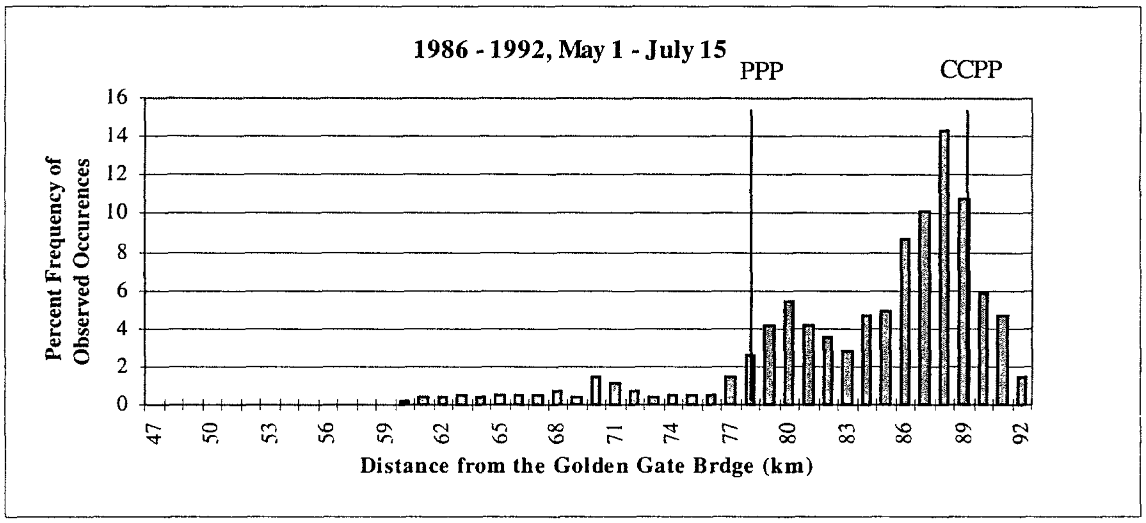
Impingement on the existing intake screens is expected to be eliminated by use of the AFB and impingement on the AFB itself should be minimal. The approach velocity for the AFB is anticipated to be approximately 0.02 ft/sec. Approach velocities will be periodically measured as described in the Biological Monitoring and Sampling Program in Appendix H. Laboratory studies will be undertaken to estimate impingement impacts of the AFB.

Implementation of VSD Flow Minimization, 80% of design flow usage at PPP should result in at least a 20% reduction from the entrainment amounts in Table 3-5. Implementation of AFB may result in a 80-99% reduction from the entrainment amounts in Table 3-5. Therefore, if AFB functions as expected, it should reduce impacts by another additional 60-79 percent relative to VSD.

The most recent entrainment studies, 1986 to 1992, were conducted during one of the longest periods of reduced precipitation and Delta outflow in recent history. This decreased Delta outflow, as represented by the location of X2 (X2 calculated with equations developed by Kimmerer and Monismith 1992), is depicted in Figure 3-8 for the years 1980 to 1996. Only the period of May 1 to July 15 is shown here because this was the same general period that the 1986-1992 entrainment studies were conducted. As this figure shows, the location of X2 was at or between the Pittsburg and Contra Costa power plants (middle figure) for the vast majority of the time (approximately 80%) than for either the six year period before 1986 (upper figure, 40%) or the four year period following the study period end of 1992 (lower figure, 25%).

As previously discussed in Section 2-3.0, Delta smelt may be expected to exhibit a higher probability of entrainment in low outflow years (IEP 1996) when X2 is located nearer the power plants than in high outflow years when X2 is located below the power plants. If this is true, then it would be expected that the power plants would entrain greater numbers of Delta smelt during this period than either before (pre 1986) or after (post 1992). Unfortunately, no data was collected in either of these periods to be able to verify this assumption, but as shown in Table 3-6, only a total of 4 Delta smelt were collected at the power plant during the 1986-1992 study period. Of these, one was classified as a larvae (less than ~15 mm in length) and the other three were classified as juveniles (greater than ~16 mm in length). These 4 fish were extrapolated by using the SIMBAS computer model to an estimated 39,827 (9,579 larvae and 30,248 juvenile) fish being entrained, as shown in Table 3-7, for all of the 1986-1992 sampling efforts combined.





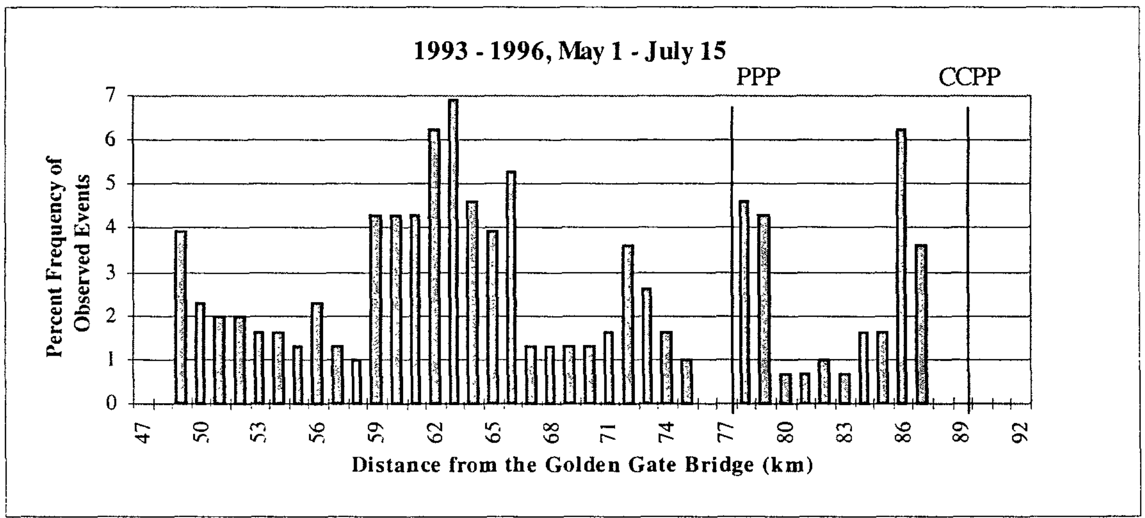


Figure 3-8. Relative frequency distribution histograms for the average location of X2 to the Pittsburg Power Plant (PPP) and the Contra Costa Power Plant (CCPP) for May 1 - July 15, 1980 - 1996.

= 1,199,903) and totaled 2,751,248. Annual entrainment estimates for the Pittsburg Power Plant are not possible because data for the power plant was only collected for a 2 ½ month period between May 1 to July 15 of these years. During this period only one Delta smelt larvae was collected resulting in an estimated entrainment of 9,579 as well as nine larval Osmerids with an estimated entrainment of 119,849. It is unknown how many of these Osmerids may have been Delta smelt. Because the peak period for larval Osmerid abundance at the power plant, based on the 1978-1979 study (Ecological Analysts, Inc. 1981a), occurs in February and March, these estimates are probably several times less than the actual annual entrainment levels. Consequently, it is not possible to directly compare larval entrainment estimates between the power plant and the CVP and SWP.

Distribution, and hence densities, of larval fish are highly affected by Delta hydrology. The Pittsburg Power Plant uses up to a maximum of 1641 cfs of Delta waters in its circulating water system. However, nearly all of this water is immediately returned back to the Delta (being replaced by water that is already present in the plants circulating water system, less evaporation from Unit 7 cooling towers, that varies from 0 to 15.6 cfs), so there is no net effect on the hydrology of the Delta. Conversely, the CVP diverts up to 4,600 cfs and the SWP generally diverts up to 6,400, but at times an additional 3,900 cfs (SWP total 10,300 cfs) of San Joaquin flow can also be diverted, which is exported out of the Delta, directly affecting the hydrology of the system. This diversion can result in a reduction of both total outflow and high spring outflow. These reductions can affect the location of the mixing zone, river flow direction, primary productivity, and survival of larval and juvenile fish (Moyle et al 1992; Sweetnam and Stevens 1993). During periods of high export pumping by the CVP and SWP, and low to moderate outflows, portions of the San Joaquin River and other channels can reverse directions, and flow toward the pumping plants. During periods of reverse, or negative outflow, out-migrating larval and juvenile fish of many species become disorientated and are carried upstream to the pumping plants where they become entrained or are preyed on by striped bass or other predators at the various pumping and water diversions. In addition, 1,800 local private water rights holders throughout the Delta also divert an additional 3,000 to 4,000 cfs during the peak irrigation season, resulting in additional fish losses (USFWS 1995).

In summary, when the same size classes of fish (i.e., juvenile Delta smelt) are compared over the same time period between the power plant and the CVP and SWP, the power plant has a lesser estimated entrainment level than the estimated salvage level for the water projects. Even when combined with the estimated entrainment from the Contra Costa Power Plant of 6,308 juvenile Delta smelt (see Section 3-2.9.4), the total estimated entrainment of the two power plants, 31,492, is still less than for the CVP and SWP, 39,777. Also, operation of the power plants either alone or in combination has very little effect on the hydrology of the Delta; nearly all the water circulated through the power plants is returned to the Delta. Conversely, the CVP and SWP export large

Any comparison of entrainment impacts between Pittsburg Power Plant and the CVP and SWP, the two largest water diverters in the Delta, is limited due to differences in the size classes of Delta smelt typically collected (or salvaged) and monitoring periods between these facilities. Between 1986 to 1992, the CVP and SWP salvaged more than 135,000 Delta smelt greater than 20 mm in length (based on the expanded salvage records of the IEP for the Sacramento-San Joaquin Estuary, CDF&G, Stockton, CA) for the May 1- July 15 period, as illustrated in Figure 3-9. During this same period, sampling at the Pittsburg Power Plant collected 3 juvenile Delta smelt, estimated entrainment of 30,248, and 10 juvenile Osmerids, estimated entrainment of 89,851, for a combined total estimated entrainment of 120,099 juvenile smelt. Undoubtedly some of these Osmerids were Delta smelt, but the exact number cannot be determined. In the latter three years of the study period, 1990-1992, when it was possible to identify all collected juvenile Osmerids to species, the Pittsburg Power Plant entrained an estimated 25,184 Delta smelt compared to a combined total of approximately 39,777 salvaged at the CVP and SWP.

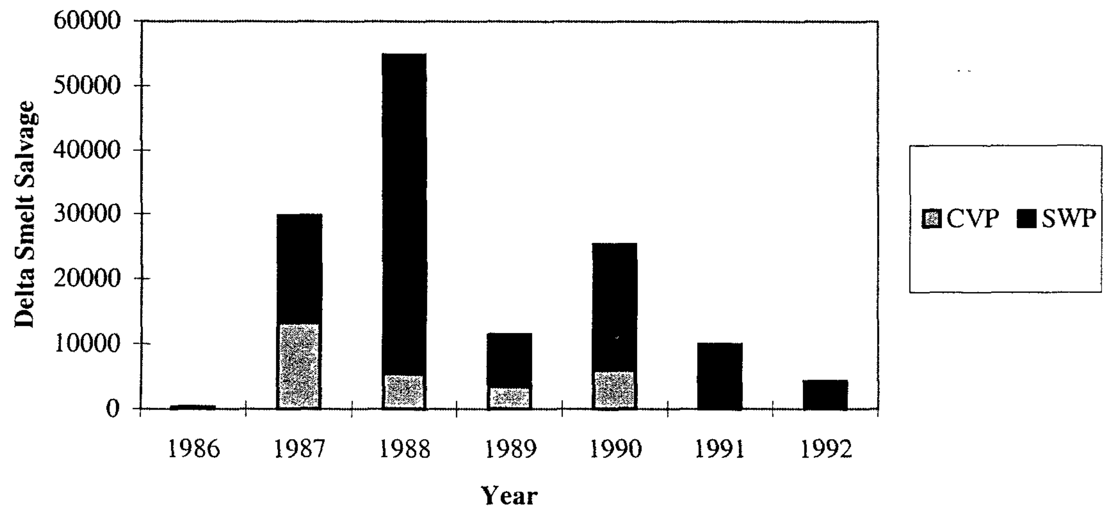


Figure 3-9. Total CVP and SWP juvenile (≥ 20 mm) Delta smelt salvage for May 1 - July 15, 1986 - 1992. (Data based on expanded salvage estimates from IEP for the Sacramento-San Joaquin Estuary, CDF&G, Stockton, CA)

Comparison of impacts on larval Delta smelt between Pittsburg Power Plant and CVP and SWP is more problematic because monthly sampling for larval fish are not routinely conducted at the water projects. Annual entrainment loss estimates for larval Delta smelt at the CVP and SWP were presented by USFWS (1995) for the period of 1989 to 1992 (1989 = 579,113; 1990 = 931,246; 1991 = 40,986 [note, no sampling conducted from April 17 to May 27, 1991]; and 1992

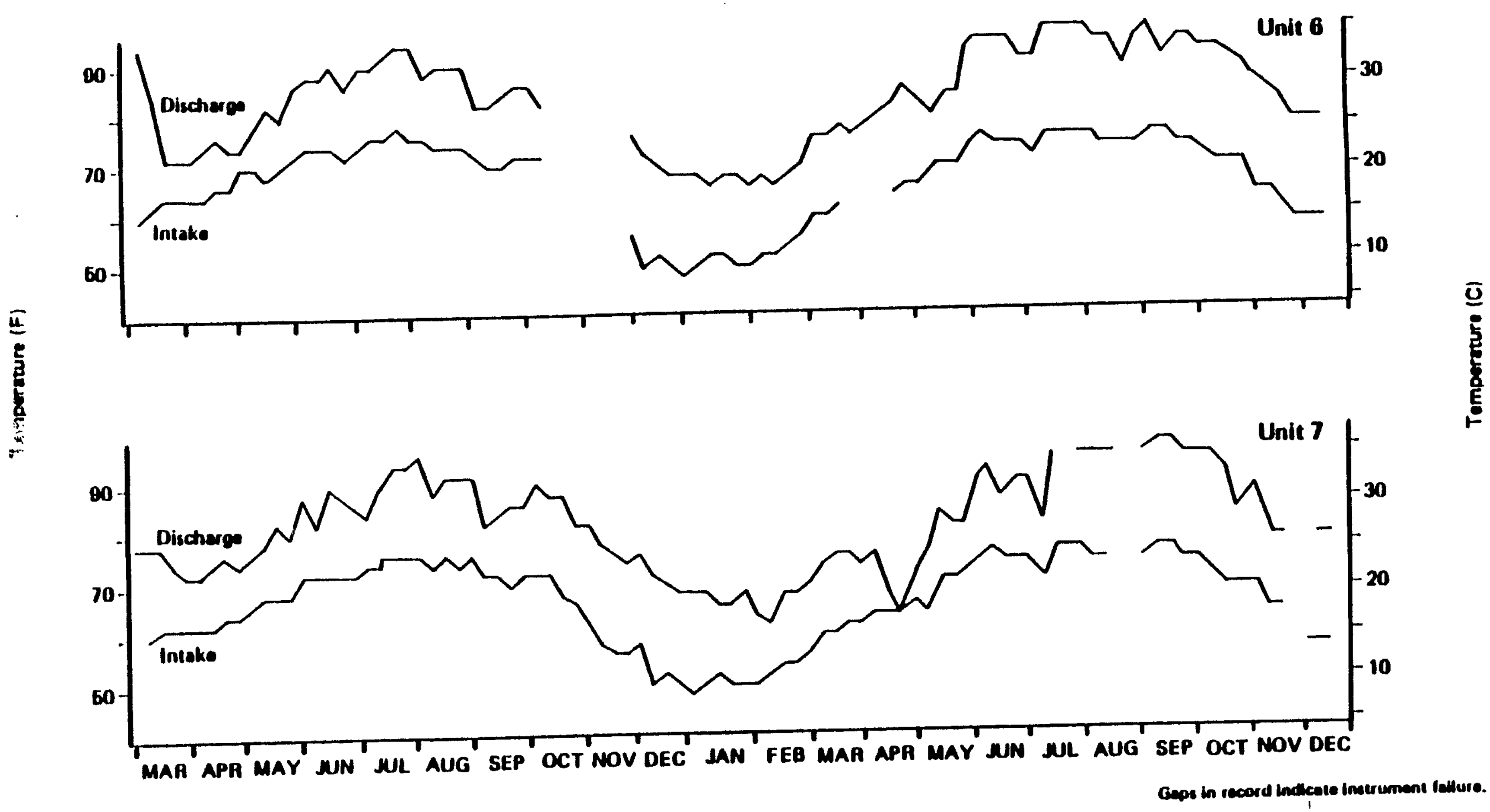


Figure 3-9. Aver‹ ›e weekly intake and discharge temperatures at Contra Costa Power Plant Units 6 and 7 (March 1978-‹ ›ecember 1979).

amounts of water, resulting in various impacts, including changes in: seasonal outflow amounts, timing and duration of high spring flows, the location of the mixing zone, river flow direction, primary productivity, export of larval fish, and survival of larval and juvenile fish that remain in the Delta. Based on the power plants location in a much broader section of the Delta and downstream of the primary spawning areas of the Delta smelt, longfin smelt, and other target species of the HCP than either the CVP and SWP, operation of the power plants would be expected to have less of an impact on year class strength of these species.

Nonetheless, implementation of VSD during Phase I and, particularly, AFB during Phase II, should it be demonstrated effective, should result in a substantial overall (80-99%) decrease in the impact of the Pittsburg Power Plant on HCP species.

3-2.5 Other Impacts

3-2.5.1 Striped Bass Monitoring Program

A. Activities

The Entrainment Abundance Sampling Program is designed to provide information on the relative abundance and temporal distribution of larval and juvenile striped bass susceptible to entrainment at the Pittsburg Power Plant between May 1 and July 15, or the date that CDFG predicts that the 38-mm striped bass is to be set, whichever is earlier. This program actually consists of two related monitoring programs: a Threshold Monitoring Program and an Entrainment Abundance Monitoring Program. The program as of July 1999 is described in NPDES Permit CA0004880 from the California Regional Water Quality Control Board (CRWQCB) San Francisco Bay Region and the **Agreement between the Pacific Gas and Electric Company and the California Department of Fish and Game for the Monitoring and Mitigation of Striped Bass in the Sacramento-San Joaquin Estuary** (PG&E 1995). The monitoring is conducted annually unless waived by mutual consent of the permittee and CDFG. To comply with the requirements of the ESA and this HCP, the take of sensitive fish species collected during the Entrainment Abundance Sampling Program will be documented. The anticipated take of sensitive species is shown in Section 3-2.5.B. Specific details of the sampling program are discussed below.

Samples of entrained organisms are collected by filtering water pumped from a power plant discharge gate well with a 4-in diameter recessed-impeller pump. Entrainment samples are preferentially collected from either Pittsburg Unit 5 or Unit 6 with 4-in PVC sampling pipes. Because of fluctuations in operation of specific units at the two power plants, on rare occasions it has been necessary to collect samples from Pittsburg Units 1-4 to ensure continuity of monitoring.

All sampling pipe intakes are directed into the circulating water flow from a location in the center of each discharge conduit. Because of turbulence and through-plant mixing, organisms are expected to be distributed more uniformly at the discharge than at the intake. This conclusion is based on special intake-discharge mass balance studies that were conducted as part of the 316(b) studies (Ecological Analysts, Inc. 1981a) for the Unit 6 intake and discharge in 1978-1979. Data collected was statistically analyzed and based on the results, it was concluded that: 1) there was no significant loss of organisms passing through the cooling water system; 2) the cooling water at the discharge was more thoroughly mixed than at the intake; and 3) the discharge was the better location for sampling entrainment abundance. To provide continuity of protocol, all sampling pipe intakes have been modified to consist of a series of 6 horizontally spaced 3/8-in X 1-1/8-in deep slots. The velocity in the sampling inlet exceeds the cooling water flow velocity, thereby preventing any back pressure around the inlet that might reduce efficient organism collection.

The entrainment sampling pump discharges into either of two 0.5-m diameter plankton nets with 0.5-mm mesh suspended in a 3-ft high by 3-ft wide cylindrical polyethylene tank. Sample volume and flow rate are measured with an annually calibrated Sparling inline flow meter mounted in the sampling pump discharge line. The flow rate during sampling is maintained at approximately 0.9 to 1.0 cubic meter/minute. This results in sampling approximately 180 or 720 cubic meters of cooling water per 3- or 12-hour sampling effort, respectively.

The plankton nets are cycled at 30-minute intervals throughout either the 3- or 12-hour sampling efforts (threshold and entrainment abundance sampling, respectively) to minimize problems of net clogging and/or abrasion and mutilation of collected organisms. The sample is then collected by rinsing the net from the outside, concentrating the organisms in a screen-walled collection container (codend). Samples are then decanted into either a 1-pint or 1-quart glass jar, preserved with either 70% isopropanol alcohol or 10% formaldehyde, and stained with rose bengal dye for subsequent processing (described below).

Each entrainment sample is sorted using a magnifying illuminator and/or dissecting microscope to remove fish larvae and eggs. Striped bass eggs and larvae are identified, counted, and the total length of larvae are measured to the nearest millimeter using a calibrated ocular micrometer. All other fish are identified to species when possible. Following identification and measurement, fish eggs and larvae are placed in labeled vials and archived. Archived samples are generally discarded after 1-year with CDFG and

CRWQCB approval. Species of special concern will be stored in separate vials with 10% formaldehyde and delivered to CDFG at the end of each monitoring season.

All sample collection, processing operations, and taxonomic identifications are performed by trained personnel and are subject to strict quality assurance standards established for this program. Standardized sample collection and processing voiding criteria are applied in the monitoring program. Results of quality assurance checks on sample collection, sample processing resorts, and taxonomic verification are maintained in onsite logs.

Sample collection and processing activities and associated data logs are periodically inspected by representatives of CDFG.

B. Impacts

Sampling may result in the pursuit, capture, harassment, harm and death of Delta smelt, longfin smelt, Sacramento splittail, chinook salmon, steelhead, and green sturgeon. Based on sampling approximately 35 acre-feet of water annually (as described above) over the term of the permit (15 years), take of these species could reach the levels shown in Table 3-11. The number of Delta and longfin smelt were calculated by proportioning the number of Osmeridae (unidentified smelt) from Table 3-6, based on the ratio of identified Delta smelt to longfin smelt over the 7-year sampling period, and then adding them to the average number of Delta smelt and longfin smelt collected over the 7 years. Specifically, 4/22 of the average May-July number of Osmerids (18) extrapolated to 15 years (270) were considered to be Delta smelt and 18/22 were considered to be longfin smelt.

Table 3-11. Anticipated Take of Acre-feet of Water and Estimated Number of Individuals Collected during the Striped Bass/Sensitive Species Monitoring Program at the Pittsburg Power Plant for the 15-Year Permit Period

SPECIES	Anticipated take
Delta smelt	The number of individuals supported by 525 acre-feet of water, estimated to be 58 individuals.
Longfin smelt	The number of individuals supported by 525 acre-feet of water, estimated to be 260 individuals.
Sacramento splittail	The number of individuals supported by 525 acre-feet of water, estimated to be 56 individuals.
Winter-run chinook salmon	The number of individuals supported by 525 acre-feet of water, estimated to be between 0-15 individuals.
Spring-run chinook salmon	The number of individuals supported by 525 acre-feet of water, estimated to be between 0 and 15 individuals.
Fall/late fall-run chinook salmon	The number of individuals supported by 525 acre-feet of water, estimated to be between 0 and 15 individuals.
Steelhead	The number of individuals supported by 525 acre-feet of water, estimated to be between 0 and 15 individuals.
Green sturgeon	The number of individuals supported by 525 acre-feet of water, estimated to be between 0 and 15 individuals.

The anticipated take levels were based on the average number of each species collected during the May-July sampling effort during the 7-year monitoring period (1986-1992) extrapolated for the 15-year permit period.

3-2.5.2 Aquatic Filter Barrier (AFB)

Recently, a new physical barrier system has been undergoing several years of demonstration tests at the Lovett Generating Station on the Hudson River, New York. This system consists of a two-layer 0.6 mm thick filter fabric made of nonwoven fibers that creates a porous filtering media with an equivalent mesh opening of 0.212 mm (supplemental holes 0.5 mm in dia. were punched 6.4 mm on center to aid in overall porosity), suspended from a flotation boom, weighted bottom, an air burst cleaning system, and concrete anchoring blocks and attachment lines. The system was first deployed in 1994 as a pilot program, and has been expanded upon in each subsequent year with increasing success. In a one month study during initial 1997 deployment, the AFB was found to have reduced entrainment by more than 80% from a non-protected adjacent unit and during a longer subsequent study, entrainment was reduced by 76% prior to a gap forming under one end, allowing unfiltered water to enter the plant (Applied Science Associates 1999). The Lovett Generating Station is sited in a similar estuarine environment with similar daily tidal elevation changes and velocities as at the Pittsburg and Contra Costa Power Plants.

Based on the positive results from the Lovett demonstration study, and its similar environmental setting to the Pittsburg and Contra Costa Power Plant, this technology, although undemonstrated at this level of flow, is promising and may be suitable for replacing the existing intake screens and resource management program to meet both the current NPDES BTA requirement to minimize striped bass losses as well as to replace the proposed VSD flow reduction to minimize the incidental take of the target aquatic species covered by this HCP. Consequently, SE proposes to conduct a test of the new AFB technology at the Contra Costa Power Plant (Phase I), and if successful, at the Pittsburg Power Plant (Phase II).

A. Activities

Testing of the AFB will include two separate monitoring programs: 1) the primary monitoring program will be ichthyoplankton sampling to determine its effectiveness at excluding fish eggs and larvae from being entrained by the power plant, (Appendix H) and 2) a secondary program to monitor the physical integrity of the AFB (Appendix I). The AFB testing will be conducted for a maximum of three test periods, unless additional testing is requested by either the USFWS, NMFS, or CDFG. The first test period is proposed for February 1 through July 31, 2002, assuming that the Phase I demonstration at the Contra Costa Power Plant is successful. VSD Flow minimization will not be conducted while the AFB is in place. If needed, additional tests in subsequent years will be conducted during the same time period. Also, tests for physical integrity of the AFB may be extended beyond the July 31 end date. Biological monitoring for AFB evaluation would be limited beyond July 31 of each year.

All units at the power plant (1-7) will be included in the Phase II study. It is anticipated that the required AFB length necessary to filter the required volume of water needed by the power plant will be approximately 3200 ft long and may extend up 850 ft offshore in basically a semi-circle configuration. The eastern end will originate on the shore approximately halfway between the existing marine terminal pier and under water cooling water discharge and the other end will terminate about 1500 ft to the west of the pier. The enclosed area is estimated to cover approximately 28 surface acres in front of the power plant with a volume of approximately 232 acre-feet of water. About 17 acres of this area consists of shallow water habitat less than 3 m below mean lower low water, which contains a narrow and sparse band of tules and cattails along the shoreline.

Evaluation of the effectiveness of the AFB will be accomplished by comparing simultaneously collected ichthyoplankton samples from both inside and outside of the barrier. Pumped samples will be collected from both the inside and outside at various areas along the AFB as well as at the discharge conduit as described in Section 3-2.5.1. Samples along the AFB will be collected either by placing sampling equipment on a barge adjacent to it or by extending sampling lines from shore based pumps. Sampling equipment and methodologies will be the same for each sampling location and will follow the protocols described in the previous section for striped bass entrainment sampling. Additionally, a limited effort using pushnets attached to small boats both inside and outside of the AFB during initial deployment is also planned. A study plan is included in Appendix H.

Evaluation of the physical integrity as well as maintenance of the AFB will be accomplished by: (a) physical inspection by divers to ensure the integrity of the AFB with the bottom and the integrity of the panels, (b) observing that the boom is sufficiently suspending the AFB in the water column, (c) monitoring tension meters on selected tethering lines to determine system integrity, (d) monitoring differential head between the inside and outside of the AFB, (e) monitoring the overall appearance of the AFB by video camera to the power plant operations control room, (f) implementing a regular inspection and replacement program for tether lines and shackles, filter panels and other worn parts and (g) by observing any dramatic changes in efficacy in reducing entrainment. The physical integrity study plan is presented in Appendix I.

B. Impacts

The AFB will create a temporary artificial embayment of approximately 28 surface acres with 17 acres of shallow water habitat less than 3 m deep. All of the fish and invertebrates within the enclosure will be subject to an increased level of potential entrainment and impingement on the power plant intake screens. Larger fish either not entrained or impinged will be subject to reduced forage species (i.e., small fish and invertebrates), and increased mortality. To help minimize this impact, SE will conduct a fish rescue within the enclosure with an electrofishing boat and/or seines. The effort expended and success criteria will be determined in consultation with USFWS, NMFS and CDFG. The placement of the AFB on the shoreline will also require the removal of approximately 0.04 acres of emergent vegetation (i.e., tules and cattails).

Sampling may result in the pursuit, capture, harassment, harm, and death of Delta smelt, longfin smelt, Sacrament splittail, chinook salmon, steelhead, and green sturgeon. Based on collecting 1,250 number of samples and approximately 30 acre-feet of water per test period (February 1-July 31), as described above, take of these species could reach between about 640 to 6,400 for Delta smelt, 635 to 6,350 for longfin smelt, 6 and 57 for Sacramento splittail, and 2 to 23 for chinook salmon. These estimates were determined based on the general density levels of these species found during the 1978-1979 sampling periods and the adjusted current potential entrainment levels presented in Table 3-5. No estimates were made for either steelhead or green sturgeon because neither of these species were entrained during the 1978-1979 studies.

CONTRA COSTA POWER PLANT

3-2.6 Construction, Maintenance, and Repair Activities -Contra Costa Power Plant

SE is proposing a phased adaptive management plan for the HCP conservation measures. Phase I will be comprised of demonstration testing of an AFB at Contra Costa Power Plant while using VSD Flow Minimization at Pittsburg Power Plant. Phase II is comprised of continued use of the AFB at CCPP if it is shown effective and implementation of a demonstration of the AFB at Pittsburg Power Plant. Should the AFB not be found effective at CCPP, the VSD Flow Minimization program will be implemented in lieu of AFB. Phase III is the implementation of the plan to create the Montezuma Enhancement Site.

Implementation of the proposed HCP conservation measures may include construction activities necessary to deploy, monitor and maintain an aquatic filter barrier (AFB) at the Contra Costa Power Plant. Such activities would take place in Phase I. If the biological monitoring and sampling program in the Phase I demonstration at the Contra Costa Power Plant demonstrates that

AFB is effective in substantially reducing impacts to HCP species, then the AFB would continue to be deployed and maintained at the Contra Costa Power Plant and would be deployed at the Pittsburg Power Plant in Phase II. The biological monitoring and sampling program was developed in consultation with USFWS, NMFS, and the CDFG. Further, the safe and efficient operation of the Contra Costa Power Plant requires continual maintenance and repair. Maintenance and repair means all current and future activities (construction, dismantling, reconstruction, environmental retrofitting, etc.) necessary to ensure the legal, safe and efficient operations within the HCP area.

Construction Activities Covered in the HCP. Those activities which may result in incidental take of sensitive fish, wildlife or plant species include:

- Removal of riprap and emergent vegetation in an area of approximately twenty feet wide by forty-feet long along the shoreline at the Contra Costa Power Plant in order to anchor and seal each end of the AFB
- Placement of an AFB of approximately 1,700 feet long in the water column in a semicircular arc, encompassing an area of approximately eight acres; including placement of the AFB on the bottom sediments comprising an area of approximately 15 feet wide along the length of the AFB; installation of anchors, monitoring instruments, tethering lines, and airlines.
- Clearing of an area of approximately 20 feet x 50 feet and construction thereon of a small boat ramp necessary to maintain and conduct biological monitoring and sampling of the AFB and to utilize for construction and maintenance activities of the AFB.

Maintenance Activities Covered in the HCP. Those activities which may result in incidental take of sensitive fish, wildlife, or plant species include:

- Maintenance and repair of power plant facilities, including, but not limited to, all related buildings, structures (including intake, AFB, shoreline maintenance, other screening systems and intake forebay dredging), fixtures, improvements, land and water uses, equipment, machinery, and operational accouterments and appurtenances.
- Maintenance and repair of electric transmission and distribution systems, whether above or below ground, including, but not limited to, all related towers, poles, transformers, anchor lines, anchors, vaults, manholes, and access roads, together with other related fixtures, equipment, machinery, improvements, and operational accouterments and appurtenances.

- Maintenance and repair of electrical substations, including all related buildings, structures, land uses, poles, lines, anchor lines, anchors, pads, transformers, towers, together with other operational improvements, fixtures, equipment, machinery, and operational accouterments and appurtenances.

- Maintenance and repair of telecommunication systems, including all related buildings, structures, land uses, towers, poles, antennae, vaults, lines, switches, and other related fixtures, equipment, machinery, improvements, and operational accouterments and appurtenances.

- Maintenance and repair of natural gas and fossil fuel systems, including, but not limited to, all related buildings, structures, storage facilities, pipes, equipment, fixtures, equipment, machinery, improvements, and operational accouterments and appurtenances.

- Maintenance and repair of other facilities, above or below ground or water, such as, but not limited to, roads, access routes, vegetation, waterways, fences, fuel lines, water pipes, conduits, antennae, or lines of any kind, together with other related fixtures, poles, towers, equipment, machinery, improvements, and operational accouterments and appurtenances.

- Maintenance and repair of all structures, facilities, and equipment, above or below ground, in our out of water, necessary or appropriate for maintaining, inspecting and monitoring the AFB.

Maintenance Activities Not Covered in the HCP. Maintenance and repair activities not related to power plant operations on property on and adjacent to the power plant site may occur within the HCP boundary and could also result in the incidental take of sensitive fish, wildlife and plant species. However, these activities are excluded from this HCP because they are either not conducted by SE or they are subject to permitting processes that already require the federal and state Endangered Species Acts to be satisfied before the activity is authorized. These excluded activities include:

- Mosquito abatement;
- Vegetation management
- Underground pipelines maintenance,
- Utility equipment maintenance, and
- Hazardous Materials site remediation.

3-2.7 Construction, Maintenance and Repair Impacts

Because there are no sensitive terrestrial species or habitat associated with the Contra Costa Power Plant, there is no anticipated take of terrestrial species during the term of the permit.

The construction, maintenance and repair activities that could result in impacts to sensitive aquatic species are those associated with the circulating water intake and discharge system or those activities associated with deployment and maintenance of the AFB. These activities could result in direct mortality to sensitive species as a result of excavation activities and use of heavy equipment or machinery.

Although the number of individuals cannot be accurately determined, an estimate of the number of sensitive species subject to take during the term of the permit can be made. This take, generally meaning harassing, harming, wounding, or killing individuals, would result primarily from vehicle and equipment use during the performance of maintenance and repair activities. Construction and deployment of AFB would likely result in little mortality or injury to listed species as it would be installed during periods in which larvae and juveniles of the listed aquatic species would either not be present or when they are at relatively low abundance. Further, once deployed, the interior of the AFB would be electrofished and/or seined, to return all listed fish species back to the Delta outside the AFB enclosure. Laying of anchors and cables, however, may result in short-term increases in suspension of bottom sediment , but should be localized and result in few impacts to sensitive species. AFB deployment at Contra Costa will, however, result in the loss of 8 acres of Bay-Delta aquatic habitat and 2.6 acres of nearshore habitat. The estimates are the maximum level of take, based on the anticipated construction, maintenance and repair activities associated with VSD at Contra Costa Power Plant during the term of the permit (Table 3-12). As noted, implementation of AFB should, if it performs as expected, result in fewer impacts to sensitive aquatic species, and VSD would not be implemented if AFB is effective.

Table 3-12. Anticipated Take of Acre-feet of Water Resulting from the Maintenance and Repair Activities at Contra Costa Power Plant with VSD Flow Minimization

SPECIES	Estimated take[1]
Delta smelt	The number of individuals within 150 ac ft of water [2]. (Estimated to be between 5-10 individuals)[3]
Longfin smelt	The number of individuals within 150 ac ft of water [2]. (Estimated to be between 0-10 individuals)[3]
Winter-run chinook salmon	The number of individuals within 150 ac ft of water [2]. (Estimated to be between 0-1 individual)[3]
Spring-run chinook salmon	The number of individuals within 150 ac ft of water [2]. (Estimated to be between 0-3 individual)[3]
Fall/late fall-run chinook salmon	The number of individuals within 150 ac ft of water [2]. (Estimated to be between 0-3 individual)[3]
Sacramento splittail	The number of individuals within 150 ac ft of water [2]. (Estimated to be between 10-60 individuals)[3]
Steelhead	The number of individuals within 150 ac ft of water [2]. (Estimated to be between 0-1 individual)[3]
Green sturgeon	The number of individuals within 150 ac ft of water [2]. (Estimated to be between 0-1 individual)[3]

[1] Take generally means harassing, harming, wounding, or killing individuals.
[2] Take based on estimate of annually disturbing 0.5 surface-acres of water to a depth of twenty feet for the term of the permit (15 years).
[3] Based on 316(b) 1978-79 and 1986-92 density (# per acre ft) values multiplied by 150.

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3.2-8 Environmental Setting and Operation Activities

Operation of the Contra Costa Power Plant requires a significant volume of Delta water for condenser cooling that may result in the take of sensitive aquatic species. The following is a description of the environmental setting and operation of the circulating cooling water system at the power plant.

The Contra Costa Power Plant is located on the western edge of the Sacramento-San Joaquin Delta, on the south bank of the San Joaquin River (Figure 3-1). The plant is 2.5 miles east of Antioch, 1 mile west of the Highway 160 Antioch Bridge, and 60 miles northeast of San Francisco. The plant is 56 miles (90km) by water from the Golden Gate Bridge. The Delta system consists of numerous islands surrounded by marshes, mudflats and a complex network of waterways. The Delta encompasses 1,150 square miles, of which only 7% remains as surface water.

Freshwater inflows to the Delta are highly regulated through numerous water storage and delivery projects, primarily the State Water Project and the Central Valley Project. Consequently, salinity and flow patterns are highly variable in the Delta and bays. Large quantities of water are used by industrial, municipal, and agricultural diversions. The shoreline adjacent to the power plant has been developed for various industries, including paper, chemical, and gypsum wallboard production.

Adjacent to the plant, the San Joaquin River is about 3,600 ft wide and has a maximum depth of approximately 30 ft at the shipping channel on the northern side of the river. Ambient river temperature near the plant varies from about 44°F in December and January to about 76°F in midsummer. Mean ambient water temperatures near the plant typically exceed 72 °F from June through August or September. Salinity near the Contra Costa Power Plant generally varies annually from 0 to about 1.5 ppt, but maximum salinity at the plant has reached 2.5 ppt. Salinity intrusion into the Delta varies with the tide and volume of freshwater outflow. Average tidal flow in front of the plant is 170,000 cfs. The direction of water flow in the San Joaquin River adjacent to the plant is tidally dependent; therefore, discharged cooling water may extend up the river at times. The two intake locations for all units of the Contra Costa Power Plant are between the two discharge facilities, consequently recirculation of discharged water results. Units 6 and 7 have a higher degree of recirculation due to the intake/discharge configuration.

The Contra Costa Power Plant is a natural gas fueled plant consisting of seven generation units. The net generating capacity of the facility is 680 MWe in year 2000. The power plant is divided into three facilities. Units 1-3 and 4- 5 were built in 1951 and 1953, respectively. Units 6 and 7 were added in 1964, doubling the plant's gross generating capacity. Units 1-3 and accompanying small house generating units are retired, and Units 4 and 5 generators are used as synchronous condensers and no longer use water from the circulating cooling water pumps. At the present, Units 6 and 7 are the only units regularly producing electricity. Unit 8, a 530 net MW combined cycle, ~~has been proposed for construction~~ to the east of Units 6 & 7. Units 6 and 7 use once-through cooling water, in which ambient Delta water is continually pumped through the plant to remove excess heat from the condensers and discharged back into the Delta. Unit 8 will utilize a mechanical draft, wet cooling tower with makeup water normally supplied from the cooling water discharge of Units 6 & 7. When Units 6 & 7 are not in operation makeup water will be supplied from the Unit 6 & 7 cooling water intake structure. Table 3-13 gives individual electrical output design and circulating water flows for each unit.

Table 3-13. Electrical Output and Circulating Cooling Water Flows for Each Unit at Contra Costa Power Plant

	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Other*	Total
Original Capacity (MWe)	113	113	113	122	120	345	345	27	1,298
Flow (cfs)	200	200	200	123	123	340	340	0	1,526
Volume (ac-ft/day)	396.7	396.7	396.7	244	244	674.4	674.4	0	3,026.9
	Unit 1	**Unit 2**	**Unit 3**	**Unit 4**	**Unit 5**	**Unit 6**	**Unit 7**	**Unit 8 planned**	**Total**
Current and planned Capacity Net(MWe)	0	0	0	0	0	340	340	530	1210
Flow (cfs)	0	0	0	0	0	340	340	17	697
Volume (ac-ft/day)	0	0	0	0	0	674.4	674.4	33.4	1,382.2

* House Units; circulating water system used water from Units 1-3 intake system

The circulating water absorbs heat during plant operation and is discharged at elevated temperatures. The potential impacts of the heated water on organisms in the receiving waters include behavioral avoidance and attraction, migration blockage, sublethal stresses, and acute mortality. The differences between discharge and ambient temperatures for Units 1-5 and Units 6&7 during studies conducted in 1978-79 are shown in Figures 3-10 and 3-11 (data from 316(b) demonstration, Ecological Analysts, Inc. 1981b).

3-2.8.1 Units 1-5 Circulating Water System

Descriptions of Units 1-5 are included for completeness. Unit 1-5 no longer utilize circulating cooling water.

The circulating water system serving Units 1-5 is depicted in Figure 3-12 and shown schematically in Figure 3-13. Circulating water for Units 1-5 is withdrawn from the river at a point approximately 250 ft offshore through two 12-ft-diameter intake tunnels, which deliver circulating water to a conventional screenhouse onshore. The circulating water pumps of Units 1-3 are located inside the turbine generator building. Those of Units 4 and 5 are adjacent to the intake screen structure. The water is returned to the river through a common discharge tunnel connected to two parallel discharge conduits that discharge into a channel located approximately 600 ft southwest of the Units 1-5 intake structure. Specifications for the system are presented in Table 3-14.

Figure 3-14 shows the major features of the intake structure. Bar racks spaced 3.5 inches on center are located about 250 ft in front of the vertical traveling screens and prevent the entry of large objects into the cooling water system. The vertical traveling screens with a mesh size of 3/8 inch retain smaller objects. Debris, along with fish and invertebrates retained by the screens, is removed during screen rotation and washing, which is initiated either automatically or manually at about 4-hour intervals under normal operating conditions, or when the across-screen hydraulic pressure exceeds a predetermined maximum. During screen washing, high-pressure (95-psi) spray nozzles wash debris and impinged organisms into a surrounding sluiceway that empties into a large-diameter gravity conduit. The screenwash is discharged from the conduit near the shore just east of the intake tunnels (Figure 3-12). Each of the units is equipped with two circulating water pumps that supply cooling water to the unit's steam condenser. Units 1-3 circulating water pumps have a capacity of 44,800 gpm (100 cfs) each, and those serving Units 4 and 5 have a capacity of 27,700 gpm (62 cfs).

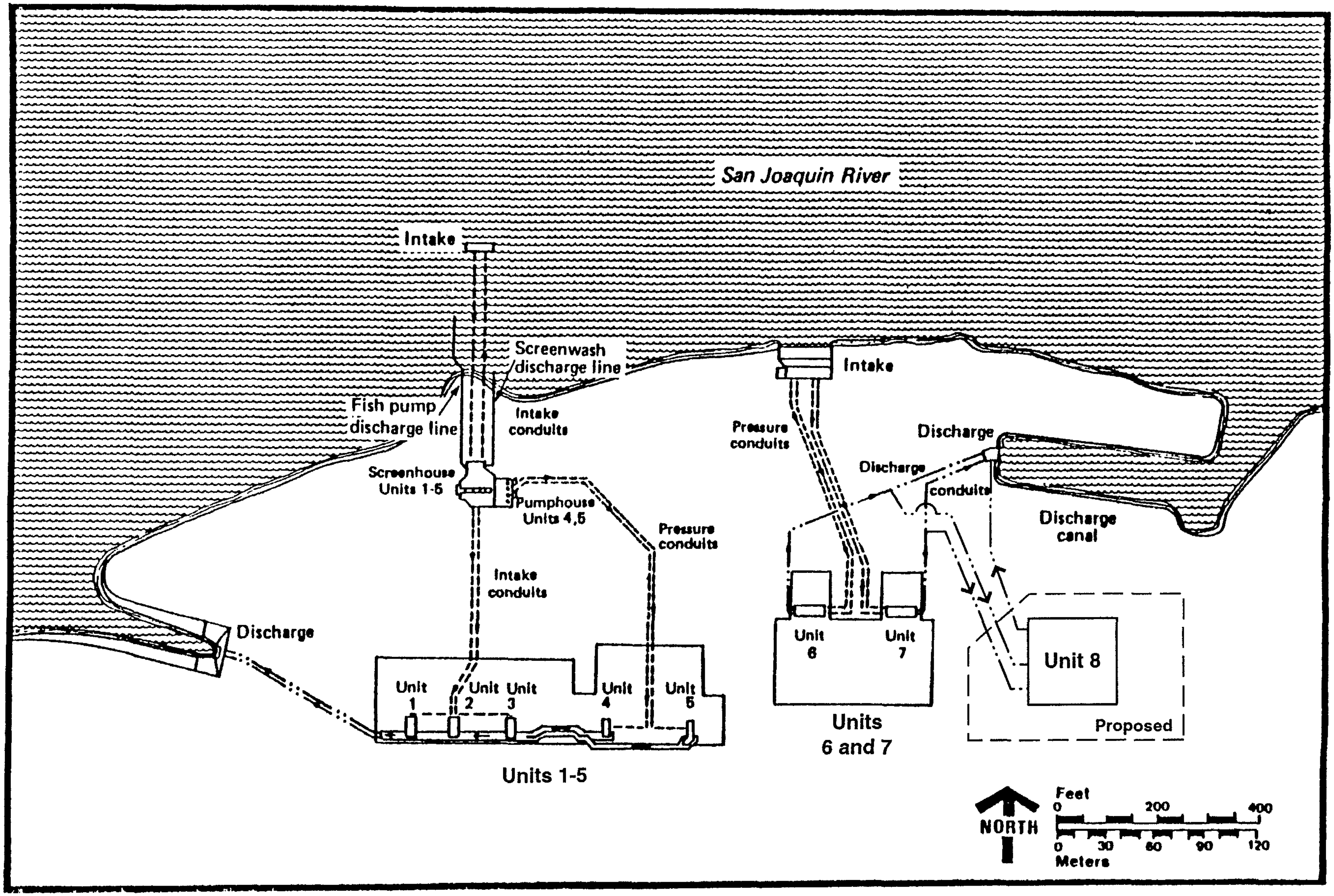

Figure 3-10. General configuration of Contra Costa Power Plant circulating water system.

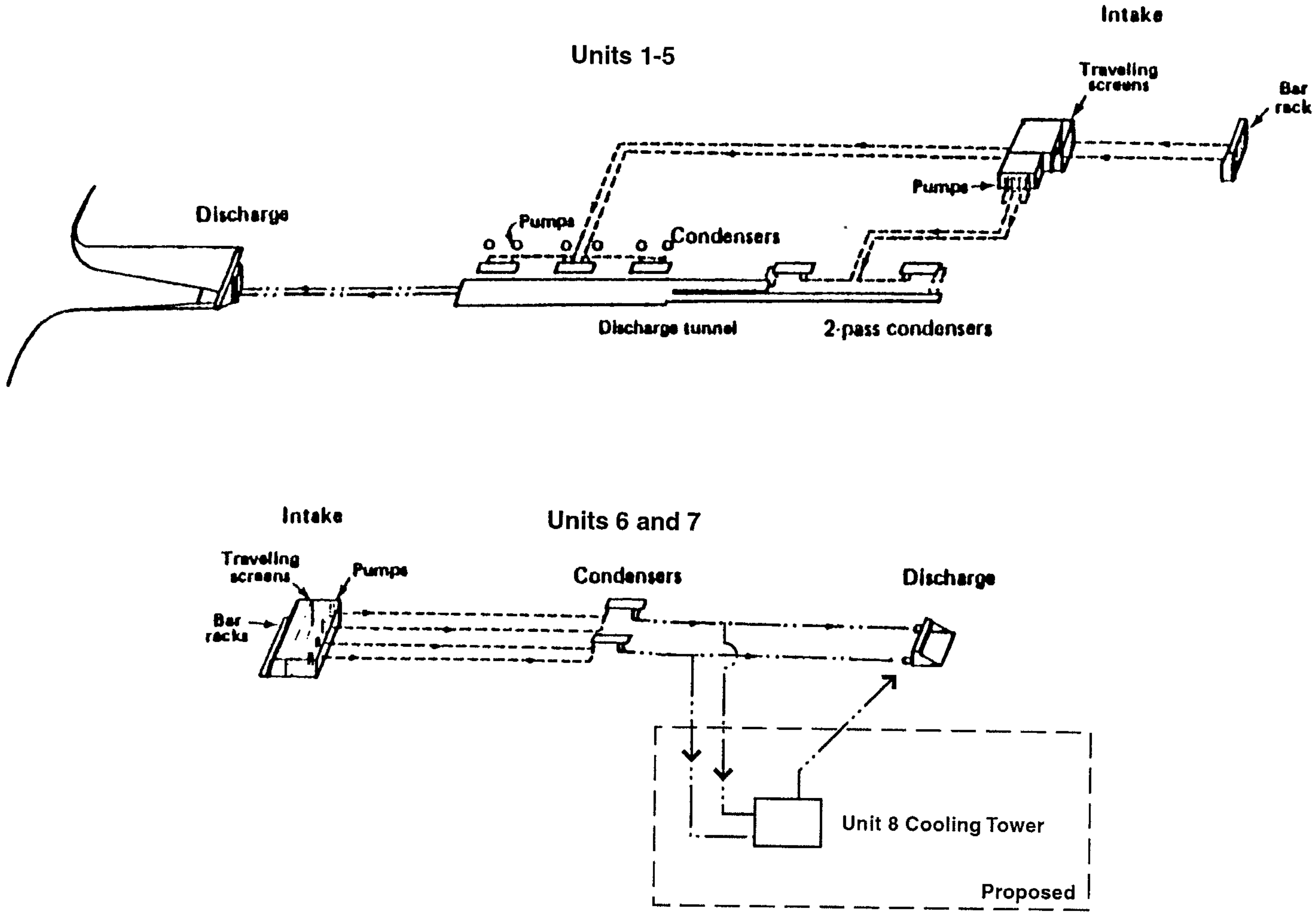

Figure 3-11. Schematic diagram of the Contra Costa Power Plant circulating water system.

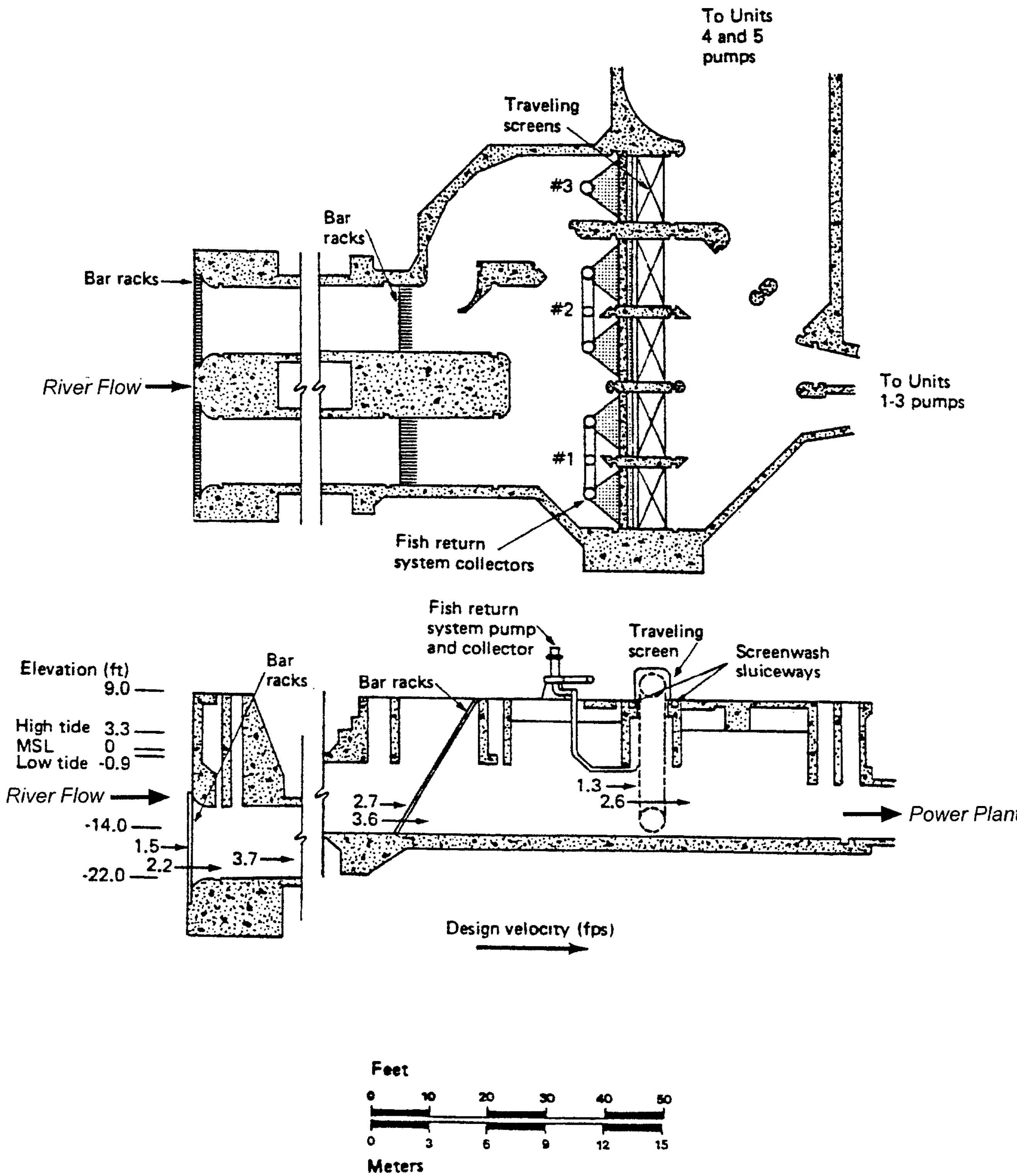

Figure 3-12. Plan and section schematic diagrams of Contra Costa Power Plant Units 1-5 intake structure.

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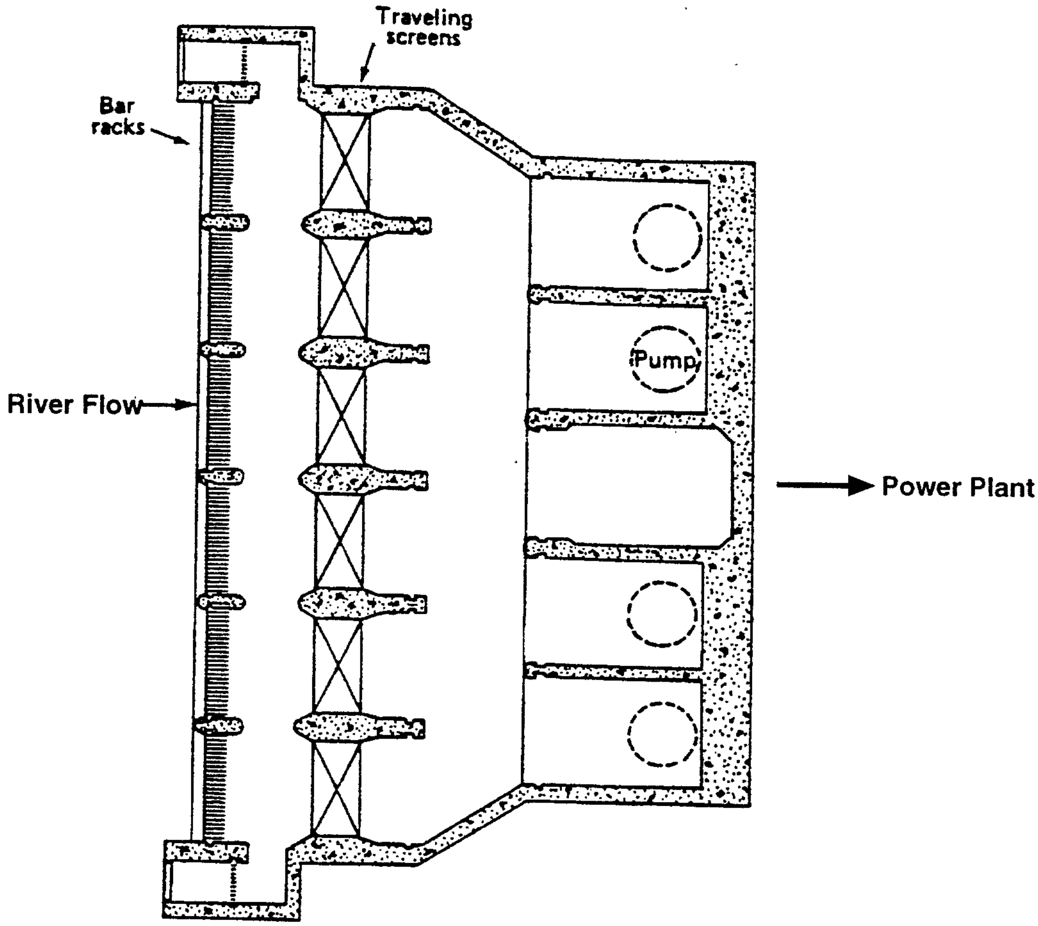

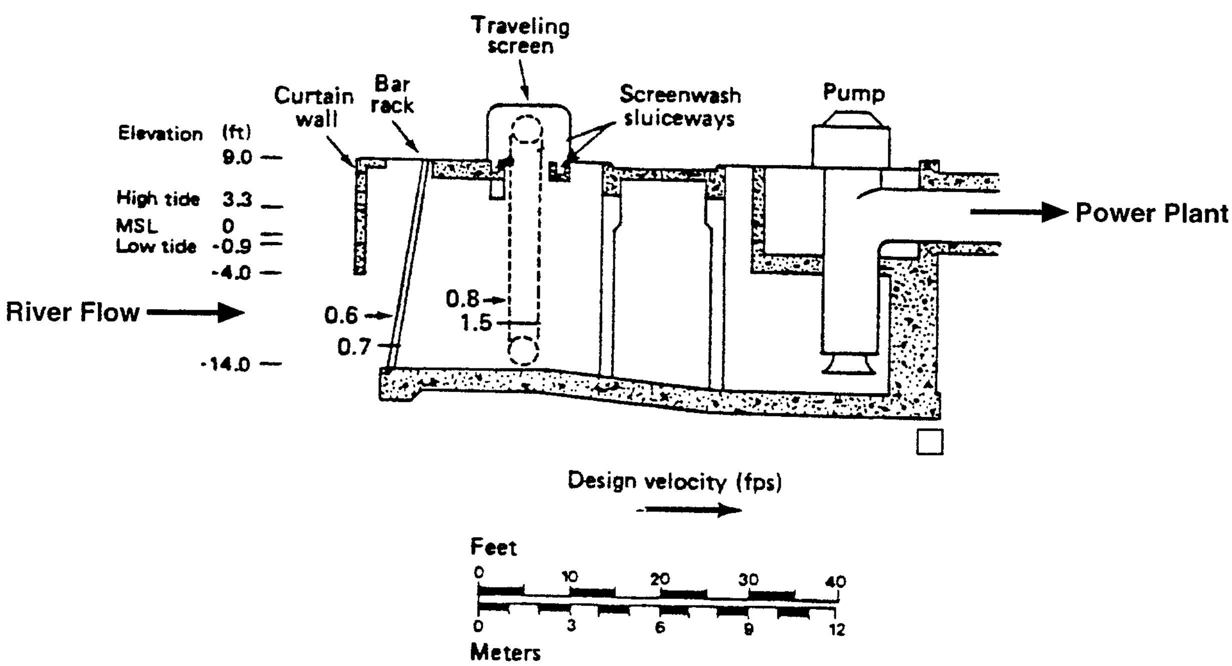

Figure 3-13. Plan and section schematic diagrams of Contra Costa Power Plant Units 6 & 7 intake structure.

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Table 3-14. Specifications of the Circulating Water Systems at Contra Costa Power Plant

Specification	Units 1-3	Units 4 and 5	Units 6 and 7
Bar racks			
Number		Units 1 -5 share a common intake structure	6
Location	Onshore		Shoreline
Spacing O.C. (in.)	3.5		3.4
Bar size (in.)	2.5 x 0.04		3.0 x 0.04
Traveling screens			
Location	Onshore	Units 1 -5 share a common intake structure	Shoreline
Number	5		6
Manufacturer	Link Belt		Link Belt
Mesh size (in.)	0.375		0.375
Pumps			
Location	Inside plant	Onshore	Shoreline
Number	2	2	2
Manufacturer	Ingersoll-Rand	Foster Wheeler	Westinghouse
Type	Mixed flow single stage vertical	Mixed flow single stage vertical	Mixed flow single stage vertical
Capacity (each pump)			
Cfs	99.8	61.7	170.2
Gpm	44,800	27,700	76,400
Pressure conduits to condenser			
Number	2	1	2
Diameter (ft.)	4	5	5.5
Length (ft.)	20	750	500
Condensers			
Number of tubes	7,796	8,980	10,756
Tube material	Aluminum/brass	Aluminum/brass	Aluminum/brass
Tube O.D. (in.)	0.875	0.875	1
Tube length (ft.)	28	28	48
Design delta-T (°F)	16	25	21
Discharge Conduits			
Number	2	2[1]	1
Size (ft.)	6.5 x 7	6.5 x 7	8
Length (ft.)	390 (Unit 1)	770 (Unit 4)	600 (Unit 6)
	490 (Unit 2)	950 (Unit 5)	447 (Unit 7)
	590 (Unit 3)		
Approximate Travel Time (sec.)			
River to pumps	256	140	60
Pumps to condenser	10	126	70
Through condenser	4	8	6.9
Condenser to discharge	45 (Unit 1)	102 (Unit 4)	90 (Unit 6)
	60 (Unit 2)	129 (Unit 5)	67 (Unit 7)
	75 (Unit 3)		
Total through plant	315 (Unit 1)	376 (Unit 4)	227 (Unit 6)
	330 (Unit 2)	403 (Unit 5)	204 (Unit 7)
	345 (Unit 3)		
Total heated	49 (Unit 1)	110 (Unit 4)	97 (Unit 6)
	64 (Unit 2)	137 (Unit 5)	74 (Unit 7)

Specification	Units 1-3	Units 4 and 5	Units 6 and 7
	79 (Unit 3)		
Total chlorinated [2]	145 (Unit 1)	236 (Unit 4)	167 (Unit 6)
	160 (Unit 2)	263 (Unit 5)	144 (Unit 7)
	175 (Unit 3)		
Design water velocities (fps)			
Through intake tunnel	3.8	3.8	NA
Approach to bar racks	2.7	2.7	0.6
Through bar racks	3.6	3.6	0.7
Approach to screens	1.3	1.3	0.8
Through screens	2.6	2.6	1.5
Screens to pumps	5.1	NA	NA
Pumps to condenser	NA	6.3	7.2
Through condenser	7.0	7.0	7.0
Condenser to discharge	6.9	5.2	7.6

[1] Units 1-3 and 4 and 5 share the same two discharge conduits
[2] Based on the time between chlorine injection and point of discharge.

Units 1-3 circulating water pumps also supply cooling water to their respective house unit steam condensers. In addition, Units 1-3 have four 3,000-gpm auxiliary pumps that supply water for other unit needs. Two auxiliary pumps (13.4-cfs) usually provide an adequate supply of water for these other needs. Under normal operating conditions, the combined flow rate of Units 1-5 is 391,600 gpm (872 cfs). The volume of water from the auxiliary pumps constitutes less than 3% of the Units 1-5 circulating water flow. The auxiliary pumps supply water for Unit 4 & 5 synchronous condenser operation, boiler water makeup and other auxiliary system needs.

Circulating water is under pressure from the discharge of the circulating water pumps to the discharge structure. Pressure increases from atmospheric (about 14.7 psi) at the intake to 23.0 psi at the circulating water pump discharge of Units 1-3 and to 29.9 psi at Units 4 and 5. Pressure drops through the cooling water system, with a drop of 4.4 psi across the Units 1-3 condensers and 10.7 psi across the Units 4 and 5 condensers. Relative pressures do not change during various tidal stages. The design delta-T is 16°F under normal full-load operation for Units 1-3 and 25°F for Units 4 and 5.

A chlorine product is injected into the cooling water system to prevent condenser biofouling. One chlorination system services all seven units. The two injection points for Units 1-3 are at the mouths of the two intake tunnels, immediately downstream of the intake screens serving Units 1-3. One tunnel serves Unit 1 and one half of Unit 2; the other serves Unit 3 and the other half of Unit 2. The Units 4 and 5 chlorine injection system consists of two injection points, each located immediately in front of the pair of circulating water pumps serving a unit. Chlorine is injected at each injection point on a schedule that varies with season and need (as determined by inspection). For most of the year, 40 minutes per injection point per week is sufficient, but the frequency is sometimes increased to 2-3 times per week for 40 minutes each time during periods of low summer flows when algal growth is heavy. For Units 1-3, the two intake tunnels are chlorinated in sequence. After Units 1-3 are chlorinated, Units 4 and 5 are chlorinated separately. Chlorinated water combines with unchlorinated water from the other units at the condenser outlet as it discharges to the common discharge tunnel. Because the chlorination system is not automatic, the cycle (including Units 6 and 7) takes 6-7 hours. The discharge limit for total residual chlorine in the discharge is 0.05 mg/l as specified in the 1995 NPDES discharge permit.

The combination of an offshore intake and a long intake tunnel at Units 1-5 creates the potential to trap large numbers of fish in front of the vertical traveling screens. High velocities in the intake tunnel act as a barrier to escape back to the river. To reduce the potential of trapping fish, a fish removal system was installed (Figures 3-12 and 3-14) that removes fish from the intake and returns them to the river. The fish pump return system includes five dustpan-shaped collectors attached to the base of the curtain wall and extends to within 5 inches of the face of each of the five vertical traveling intake screens. The top of each collector is open on the downstream side of the curtain wall, which is approximately 1-1/2 ft in front of the intake screens (Figure 3-14). The collectors converge into a 6-inch suction line for a single collector and 8-inch suction lines for the two paired collectors. The five collectors feed into three low-head, open-impeller centrifugal pumps that discharge into a common 16-inch pipe that returns diverted fish to the river. The submerged discharge is approximately 125 ft from the shoreline and adjacent to a pier extending from the shore to the intake structure on the west side of the intake conduits. With all three fish pumps in operation, the flow through the return system is about 2,500 gpm.

3-2.8.2 Units 6 and 7 Circulating Water System

The circulating water system serving Units 6 and 7 is depicted in Figure 3-12 and shown schematically in Figure 3-15. Its intake structure, located on the shoreline 600 ft east of the Units 1-5 intake structure, also consists of bar racks, traveling screens, chlorination facilities, and circulating water pumps. Separate intake conduits conduct circulating water to the condenser halves of Units 6 and 7. The circulating water from the two condenser halves of each unit combines at the condenser outlet. The circulating water flows of Unit 6 remain separate from those of Unit 7 during transit through their respective condensers and discharge tunnels, and the two streams combine at the point of discharge into a discharge channel. The outfall from the channel to the river is located approximately 800 ft east of the Unit 6 and 7 intake structure.

Circulating system design specifications are presented in Table 3-14. Figure 3-15 shows the major features of the intake structure. Bar racks, spaced 3.4 inches on center are located about 15 ft in front of the vertical traveling screens. The traveling screens have 3/8 inch mesh. Debris, along with fish and invertebrates retained by the screens, is removed during the screen rotation and washing, which is initiated either by a timer at about 4-hour intervals under normal operating conditions, or when the across-screen hydraulic differential exceeds a predetermined maximum.

During screen washing, high-pressure (110-psi) spray nozzles wash debris and impinged organisms into a surrounding sluiceway that empties into a screenwash wet well. The screenwash discharge is returned to the river by large-diameter trash pumps. The centrifugal, vertical, open-impeller pumps are activated sequentially as the wet well fills with screenwash by pedestal float switches, and they run until the well is empty. The pumps discharge into an 18-inch-diameter concrete pipe that empties into the discharge conduit of Unit 6.

During normal operation, for equipment safety and system reliability, each unit's two 76,400-gpm (170-cfs) circulating water pumps are run simultaneously and furnish 306,000 gpm (680 cfs) of circulating water to the Units 6 and 7 condensers. Single-pump operation occurs only during maintenance inspections and outages. In single-pump operation, electrical generation is limited to less than 50% of a unit's maximum capacity. These pumps were retrofitted with variable speed drive (VSD) controls in 1987, allowing them to be operated from 50% to 95% of their rated capacity. VSDs allow the pumps to be operated at minimum speed/flow under minimum generation (~25-40 MW), increasing proportionately to 95% of speed/flow at ~90-140 MW. Between ~90-140 MW and maximum generation, 330 MW, the pumps must be placed in "by-pass" mode, allowing 100% of pump speed/flow.

Circulating water is under pressure from the discharge of the circulating water pumps to the discharge structure. Pressure increases from atmospheric (about 14.7 psi) at the intake to 22.6 psi at the circulating water pump discharge. Pressure drops through the circulating water system, with about a 6.2-psi drop across the condenser. Relative pressures do not change during various tidal stages. The design delta-T is 21°F under normal full-load operation.

A chlorine product is injected into the circulating water system sequentially just ahead of each of the four circulating water pumps to prevent condenser biofouling. Units 6 and 7 are chlorinated on the same schedule as Units 1-5 for 40 minutes per condenser half, usually once a week but sometimes 2-3 times a week. Each intake conduit and corresponding condenser half is chlorinated separately to a chlorine residual of 0.2-0.5 mg/l at the inlet. The chlorination cycle usually starts at Units 1-3 and ends at Units 6 and 7. Chlorinated water from each condenser half combines with an equal amount of unchlorinated water from the other condenser half at the condenser outlet, and the combined flows for each unit remain separate from those of the other units until they discharge into the discharge channel. The limit for total residual chlorine in the discharge is 0.05 mg/l as specified in the 1995 NPDES discharge permit.

3-2.8.3 Units 8 Cooling Water System

The closed cooling water system proposed to serve Unit 8 is generally depicted by configuration in Figure 3-12 and schematically in Figure 3-15. This closed-cycle system uses mechanical-draft, wet cooling tower to dissipate the heat transferred to the circulating cooling water flow during transit through the steam condensers. In a closed-cycle system, "makeup" water is withdrawn from a source to replace that evaporated in the cooling tower or carried away in small droplets (drift) and to control the dissolved solids content of the cooling water. The portion returned to the water body with its higher concentration of minerals is called blowdown. The ratio of the water returned (blowdown) to water withdrawn (makeup) depends on a number of factors affecting the rate of evaporation, including air temperature, humidity, and wind.

Unit 8 makeup water is withdrawn from the one or both of Units 6 & 7 discharge flows. During a shutdown of both Units 6 & 7, a single circulating water pump serving Unit 6 or 7 will continue to operate to provide supply for Unit 8. A single circulating water pump for Unit 6 or 7 can operate in VSD mode at 50% capacity providing 38,200 gpm (85 cfs). Makeup water flow to Unit 8 is 7,650 gpm (17 cfs) maximum. Maximum losses from drift and evaporation have been estimated at about 2,525 gpm (5.6 cfs). Blowdown flow is discharged to the Unit 6 and 7 discharge structure. The blowdown flow varies with unit operation, weather and makeup water quality from a minimum of 5,120 gpm (11.4 cfs) during periods of maximum evaporation to nearly the full makeup water flow when the generating load is low, weather cool and makeup water quality good. Nonhazardous chemicals are used in the cooling tower to prevent condenser biofouling.

3-2.9 Operation Impacts

The Contra Costa Power Plant HCP falls within the designated critical habitat for one of the listed species, Delta smelt and a number of listed salmon ESUs. A variety of investigations at the Contra Costa Power Plant have been conducted to characterize fish losses resulting from circulating water system operations, and identify and implement measures to minimize these losses. Operation of the power plant's circulating water system has the potential for impacting aquatic organisms through entrainment, impingement, and exposure to elevated water temperatures within the thermal discharge plume. Entrainment impacts consists of those organisms that go through the circulating water system; impingement impacts consists of those organisms that are held against the intake screen; and thermal impacts consists of those organisms that are affected by the heated discharge of the circulating water after it leaves the power plant. Various past studies have documented the range of potential impacts from the plants' circulating water system for the species listed in the HCP. Each of these potential impacts are more fully described below. Aquatic monitoring programs that have addressed these issues in the past are discussed in more detail in Appendix B.

If the AFB is demonstrated effective at the Contra Costa Power Plant during Phase I, it would subsequently be implemented during Phase II at the Pittsburg Power Plant. An intensive biological monitoring program would be conducted to determine whether the AFB is effective at the plant. SE expects that if the AFB is effective, impacts to sensitive aquatic species should be reduced by approximately 80-99 percent. Even with a number of physical constraints not present at the Contra Costa Power Plant, such technology was estimated to result in an 80 percent reduction in entrainable organisms at the Lovett Generating Station on the Hudson River in New York. (Applied Science Associates 1999). AFB approach velocities are designed at 0.02 ft/sec., and impingement of sensitive aquatic organisms at this approach velocity are expected to be negligible. Further, the AFB would require the enclosure of some eight acres of the Delta area. Approximately 2.6 acres of this enclosed area would comprise shallow water habitat. This impact, would, however, be mitigated by the creation of shallow and open water habitat during Phase III. If AFB technology is not effective at the Contra Costa Power Plant, it could be removed without permanent loss of shallow water habitat that would ordinarily accrue with other screen technology.

3-2.9.1 Entrainment

Entrainment is the hydraulic capture and subsequent passage of organisms through the circulating water system. The organisms involved are small (typically, less than 20 mm long), unable to avoid the extant screens, and capable of passing through the 3/8-inch mesh of the intake screens and include eggs, larvae, and early juvenile stages of various fish species. As these entrained organisms pass through the circulating water system, they can be exposed to several types of stresses. These include mechanical, pressure, shear, thermal, and chemical stresses. The potential impact of entrainment is a function of the number of organisms that do not survive passage through the circulating water system. These screens would remain in place during Phase I and II, subject, however, to the implementation of VSD.

Based on results of entrainment monitoring (Clean Water Act 316[b] studies) conducted in 1978 and 1979 (Ecological Analysts, Inc. 1981b), estimates of the numbers of larval fish and eggs entrained annually at Contra Costa Power Plant were calculated based on actual circulating water system operations. The estimates of entrained larval Delta smelt, longfin smelt, Osmeridae (members of the smelt family not identified to species), Sacramento splittail, chinook salmon, steelhead, and green sturgeon for April 1978-April 1979) are summarized in Table 3-15. The estimates provided in Table 3-15 are from a monthly sampling program conducted over a 1-year study period, and represent entrainment levels at design flow for that year based on each month's density values. Entrainment survival can vary between 0 and 80% and is dependent on species, life stage, and circulating water temperature (Ecological Analysts, 1981b). However, because future operating conditions at the power plant are unknown, it is not possible to accurately predict survival rates on organisms entrained through the power plant.

As a consequence of the inability to taxonomically differentiate between larval longfin smelt and Delta smelt, results of entrainment monitoring performed during these studies were combined for these two species and reported in most cases only as smelt (Osmeridae). These estimates were based on a methodology that sampled less than 0.006% of the volume of water diverted through the plant during the term of the study.

The estimates provided in Table 3-15 are for all of the existing operating units at the time of the entrainment studies (1978-1979), and are a combination of separate entrainment estimates for both intake systems for Units 1-5 and Units 6&7. Units 1-3 are currently retired. Units 4&5 are currently operated as synchronous condensers, providing power quality support only and do not require cooling water from circulating water pumps. Therefore, a more representative estimate of entrainment based on the 1978-79 studies includes only the entrainment estimates for Units 6&7. These values are provided in Table 3-16.

Table 3-15. Total Number of Fish Collected during Entrainment Sampling, Estimated Annual Entrainment at for Units 1-7 at Contra Costa Power Plant for April 1978-April 1979, and Potential Current Entrainment at Full Design Flow of Circulating Water Volumes

FISH SPECIES ENTRAINED	Number of Fish Collected[1]	1978-1979 Entrainment[2]	Reduction Factor	Potential Current Entrainment[3]
Delta smelt[4]	4	21,887 ± 23,881	90%[5]	2,200
Longfin smelt	0	0	None	0
Osmeridae[6]	1,518	20,543,854 ± 5,601,594	90%[7]	2,054,400
Sacramento splittail	34	189,659 ± 118,820	62%[8]	72,000
Winter-run chinook salmon	0	0	None	0
Spring-run chinook salmon	0	0	None	0
Fall/late fall-run chinook salmon	1[9]	10,318 ± 18,820	None[10]	10,318 ± 18,820
Steelhead	0	0	None	0
Green sturgeon	0	0	None	0

1 Represents total number of fish collected during study period.
2 Estimates based on entrainment densities (April-December 1978 and from January-April 1979) and include 95% confidence interval.
3 Estimates represent maximum potential based on design flow, actual flows are less.
4 Delta smelt collected ranged in length from 26 to 47 mm.
5 Federal Register Volume 58, No. 49/ Tuesday, March 16, 1993.
6 Osmeridae collected ranged in length from 4 to 18 mm.
7 Average of reductions for Delta smelt and longfin smelt (**Sacramento/San Joaquin Delta Native Fishes Recovery Plan**, USFWS, 1996).
8 Federal Register Volume 64, No. 25/Monday, February 8, 1999.
9 The single chinook salmon collected (unknown length) was a fall/late fall-run fish and not a winter-run salmon based on the time of year it was collected (May 1978). Winter and spring-run fish at this time of year are greater than 120 mm in length, which is too large to be entrained.
10 This run was reported in the Federal Register Volume 63, No. 45/Monday, March 9, 1998, to be at or near historical levels; consequently, no reduction factor is necessary.

Table 3-16. Total Number of Fish Collected during Entrainment Sampling, Estimated Annual Entrainment for Units 6 & 7 at Contra Costa Power Plant for April 1978-April 1979, and Potential Current Entrainment at Full Design Flow of Circulating Water Volumes

FISH SPECIES ENTRAINED	Number of Fish Collected[1]	1978-1979 Entrainment[2]	Reduction Factor	Potential Current Entrainment[3]
Delta smelt[4]	2	7,662 ± 9,457	90%[5]	770
Longfin smelt	0	0	None	0
Osmeridae[6]	609	5,936,097 ± 1,317,392	90%[7]	594,000
Sacramento splittail	26	132,604 ± 67,745	62%[8]	50,400
Winter-run chinook salmon	0	0	None	0
Spring-run chinook salmon	0	0	None	0
Fall/late fall-run chinook salmon	1[9]	10,318 ± 18,820	None[10]	10,318 ± 18,820
Steelhead	0	0	None	0
Green sturgeon	0	0	None	0

1 Represents total number of fish collected during study period.
2 Estimates based on entrainment densities (April-December 1978 and from January-April 1979) and include 95% confidence interval.
3 Estimates represent maximum potential based on design flow; actual flows are less.
4 Delta smelt collected ranged in length from 26 to 47 mm.
5 Federal Register Volume 58, No. 49/ Tuesday, March 16, 1993.
6 Osmeridae collected ranged in length from 4 to 18 mm.
7 Average of reductions for Delta smelt and longfin smelt (**Sacramento/San Joaquin Delta Native Fishes Recovery Plan**, USFWS, 1996).
8 Federal Register Volume 64, No. 25/Monday, February 8, 1999.
9 The single chinook salmon collected (unknown length) was a fall/late fall-run fish and not a winter-run salmon based on the time of year it was collected (May 1978). Winter and spring-run fish at this time of year are greater than 120 mm in length, which is too large to be entrained.
10 This run was reported in the Federal Register Volume 63, No. 45/Monday, March 9, 1998 to be at or near historical levels; consequently, no reduction factor is necessary.

Because most of the species listed in Tables 3-15 and 3-16 have experienced significant declines in their populations over the past 20 or more years, a potential current entrainment column has also been included. The adjustment factors used to develop potential current entrainment estimates are based either on information from the U.S. Federal Register or from the **Sacramento/San Joaquin Delta Native Fishes Recovery Plan** (USFWS, 1996). Adjustment factors are presented for Delta smelt, Osmeridae, and splittail because specific declines in their population abundances were available from published literature. Current potential entrainment estimates for fall/late fall-run chinook salmon were not calculated because this population is believed to be at or near its historical level (U.S. Fed. Reg. Vol. 63, No. 45/Monday, March 9, 1998). No adjustment factors are presented for the other species listed because none of them were collected during the 1978-1979 entrainment studies and, therefore, no annual entrainment estimates were generated.

The USFWS (Federal Register Volume 58, No. 49/Tuesday, March 16, 1993) estimated that the entire Delta smelt population experienced nearly a 90% decline in the 20-year period prior to the species' listing in 1993. The summer townet surveys conducted by CDFG also show a general decrease over the same time period. This index for Delta smelt peaked at 65.2 in 1978, the year that most of the information on Delta smelt estimated entrainment is based; declined to 0.8 in 1982, and for all but 2 years since 1982 has been below 10. The estimated 1978-1979 annual entrainment estimates presented in Table 3-15, therefore, potentially overestimate potential current entrainment by approximately a factor of 10. Using this correction factor, the potential current entrainment estimate at full design flow of the circulating water system may be closer to 770 Delta smelt than the historical estimate of 7,662.

The adjustment factor for Osmeridae, those smelt too small to be identified as either Delta or longfin smelt, was calculated simply by using the same adjustment factor, 10, that was common to both of these species), as described previously (see Section 3-2.4.1). Consequently, the potential current entrainment estimate for Osmeridae at full design flow of the circulating water system may be closer to 594,000 than the historical estimate of 5,936,097.

Sacramento splittail have disappeared from much of their native range and their principle habitat is now limited to the Sacramento-San Joaquin estuary, especially the Delta (USFWS 1996). Within this range, the splittail population has been estimated to be 35% to 60% as abundant as they were in 1940 (CDFG 1992b in USFWS 1996), and the USFWS (Fed. Reg. Vol. 64, No. 25/ Monday, February 8, 1999) reported that they have declined by 62% over the last 15 years. As with Delta smelt, discussed above, the decline in splittail abundance occurred after the 1978-1979 studies on which Table 3-16 is based. Thus, the estimated 1978-1979 entrainment presented in this table potentially overestimates current entrainment by a factor of approximately 2.5. Using this correction factor, the annual current potential entrainment estimate at full design flow of the circulating water system may be closer to 50,400 than the historical estimate of 132,604.

It needs to be also clearly understood that the estimates presented in Table 3-16 are based on full design flow of the cooling water system of the power plant and do not represent actual 1978-1979 flows or current actual flows, both of which are less. Due to required maintenance measures, at a minimum, it would be impossible to operate the Contra Costa Power Plant at full design flow over the course of a year. The power plant is operated based on demand, which varies seasonally and annually as a function of Bay Area electrical load needs, availability of out-of-area generation, transmission line capacity factors, and what must be generated locally. Actual monthly cooling water flows for February through July (the proposed flow minimization period; see Section 4) for the years 1986 to 1999 are presented in Table E-2 in Appendix E. This data is graphically illustrated in Figure E-1 of Appendix E, and shows that circulating water flows were 95% or less of full design flow 87% of the time. As this table shows, the average monthly flows for the Contra Costa Power Plant varied between 37% and 72% of design flow, with specific actual monthly flows ranging from 0 (May 1995) to 100% (March 1987, July 1988, February 1990, March 1991, and February 1993). Using average monthly flow values, the adjusted potential current entrainment estimates discussed above could be further reduced by an additional 28-63% to more accurately reflect actual flow conditions rather than full 100% flow for the entire 6-month period (February 1-July 31).

For Delta smelt, the family Osmeridae, and splittail, the estimated annual entrainment is reduced by 65%, 71%, and 30% respectively, with only Units 6&7 operating, compared to operation of all units (1-7).

As part of a program to reduce striped bass entrainment losses, striped bass entrainment monitoring has been performed at Contra Costa Power Plant from 1986 through 1992. Each year, entrainment monitoring commenced May 1 and typically continued to mid-July. Delta smelt, longfin smelt, Sacramento splittail, chinook salmon, steelhead, and green sturgeon collected in these entrainment samples are summarized in Table 3-17. During the early period of this entrainment monitoring program (1986-1989), larval Delta smelt and longfin smelt could not be taxonomically differentiated with confidence and, therefore, results of these collections have been combined for these two species and recorded as Osmeridae. Beginning in 1990, taxonomic identification of larval delta smelt and longfin smelt improved, and the two species were recorded separately.

Table 3-17. Total Number of Fish Collected during the 1986-1992 Sampling Period and the Estimated Average May-July Entrainment for Units 1-7 at the Contra Costa Power Plant[1]

FISH SPECIES ENTRAINED	Number of fish collected from 1986-1992[2]	Estimated average May-July entrainment[3]
Delta smelt	4	11,863 ± 11,621
Longfin smelt	6	17,795 ± 14,229
Osmeridae	128	379,620 ± 428,232
Sacramento splittail	8	23,726 ± 16,426
Winter-run chinook salmon	0	0
Spring-run chinook salmon	0	0
Fall/late fall-run chinook salmon	0	0
Steelhead	0	0
Green sturgeon	0	0

[1] Data collected from May 1- July 15 each year.
[2] Represents total number of fish collected during the 7-year study period.
[3] Estimated entrainment based on design flow for a 3-month period, and includes 95% confidence interval.

Entrainment sampling during 1986-1992 was conducted only at the Units 6&7 discharge. Entrainment values for Units 1-7 used in Table 3-17 were calculated by applying the densities found at Units 6 and 7 to the total volume for Units 1-7. Units 1-3 are currently retired. Units 4 and 5 are currently operated as synchronous condensers, which do not require cooling water from circulating water pumps. Consequently, a more accurate estimate of current entrainment based on the 1986-1992 studies includes only the entrainment estimates for Units 6&7. These values are provided in Table 3-18. This table was not adjusted because most, if not all, of the population declines for the listed species had already occurred prior to the study period this table was based on.

Table 3-18. Total Number of Fish Collected during the 1986-1992 Sampling Period and the Estimated Average May-July Entrainment for Units 6&7 only at the Contra Costa Power Plant[1]

FISH SPECIES ENTRAINED	Number of fish collected from 1986-1992[2]	Estimated average May-July entrainment[3]
Delta smelt	4	5,338 ± 5,230
Longfin smelt	6	8,008 ± 6,403
Osmeridae	128	170,829 ± 192,705
Sacramento splittail	8	10,677 ± 7,392
Winter-run chinook salmon	0	0
Spring-run chinook salmon	0	0
Fall/late fall-run chinook salmon	0	0
Steelhead	0	0
Green sturgeon	0	0

[1] Data collected from May 1- July 15 each year.
[2] Represents total number of fish collected during the 7-year study period.
[3] Estimated entrainment based on design flow for a 3-month period, and includes 95% confidence interval.

Table 3-19 presents the life stage, number collected and estimated entrainment by year for Delta smelt, longfin smelt, Osmeridae, and Sacramento splittail sampled between 1986-1992. Entrainment estimates are for the months of May-July only, and were calculated by using the striped bass simulation model (SIMBAS). This computer program uses species-specific sampling densities (collected as part of the striped bass monitoring program described in Section 3-2.10) and actual circulating water volumes to calculate entrainment estimates. With the exception of 1986 and 1987, generally very few fish (0-7 per species) were collected during each year's 3-month sampling effort. Although specific length measurements were not taken for these species during the study period, all fish were originally classified as either larvae (up to 15-20 mm long, depending upon species) or juveniles (generally 16-20 mm or longer in length). As this table shows, 95 % (131) of the 138 osmerids (Delta smelt, longfin smelt, and Osmeridae combined) collected and 74 % of the total entrainment estimate for the 7-year long study were classified as larvae.

Table 3-19. Number of fish collected and Estimated May-July Entrainment by Year during the 1986-1992 Sampling Period[1] for Units 6&7 at the Contra Costa Power Plant as calculated by the SIMBAS[2] Model

Year	No. Collected/ Est. Entrainment	Species: Delta smelt Larvae[3]	Delta smelt Juvenile[4]	Longfin smelt Larvae[5]	Longfin smelt Juvenile[6]	Osmeridae Larvae[7]	Osmeridae Juvenile[8]	Sacramento splittail Larvae[3]	Sacramento splittail Juvenile[4]
1992	No. Collected	0	2	0	1	0	0	0	1
	Est. Entrainment	0	6,308	0	4,079	0	0	0	4,079
1991	No. Collected	1	0	2	0	6	0	0	2
	Est. Entrainment	5,018	0	5,913	0	18,151	0	0	5,072
1990	No. Collected	1	0	0	0	4	0	0	1
	Est. Entrainment	4,677	0	0	0	5,490	0	0	4,238
1989	No. Collected	0	0	1	0	7	0	0	2
	Est. Entrainment	0	0	1,050	0	18,602	0	0	8,975
1988	No. Collected	0	0	0	2	2	0	0	0
	Est. Entrainment	0	0	0	106,850	18,585	0	0	0
1987	No. Collected	0	0	0	0	22	2	1	0
	Est. Entrainment	0	0	0	0	111,587	9,428	4,118	0
1986	No. Collected	0	0	0	0	85	0	0	1
	Est. Entrainment	0	0	0	0	179,458	0	0	2,323
	Total Collected	2	2	3	3	126	2	1	7
	Total Entrained	9,695	6,308	6,963	110,929	351,873	9,428	4,118	24,687

[1] Data collected from May 1 - approximately mid-July.
[2] The SIMBAS Model was originally developed as part of the striped bass monitoring program and uses actual fish density data and circulating water volume data to determine entrainment estimates.
[3] Delta smelt and splittail were classified as larvae up to ~15 mm long.
[4] Delta smelt and splittail were classified as juveniles starting at ~ 16 mm long.
[5] Longfin smelt were classified as larvae up to ~ 20 mm long .
[6] Longfin smelt were classified as juveniles starting at ~ 21 mm.
[7] Osmerids were classified as larvae up to ~15-20 mm long.
[8] Osmerids were classified as juveniles starting at ~ 15-20 mm long.

For each species, the estimated annual entrainment was reduced by 55% with only Units 6&7 operating, compared to all units operating (1-7).

The significance of estimates of entrainment loss of fish larvae on populations of Delta smelt, longfin smelt, Sacramento splittail, chinook salmon, steelhead, and green sturgeon inhabiting the Bay/Delta system is difficult to assess due to the low numbers of these species that were collected, the large volumes of water over which the densities were extrapolated to estimate entrainment totals, age of the data, the large variances associated with the entrainment estimates, the seasonal timing of the 1986–1992 sampling effort, and the population declines that have occurred since the 1978-1979 sampling effort was conducted. SE has expressed take in the form of acre-feet of water, as suggested by the HCP handbook (USFWS/NMFS 1996), when the specific number of individuals is unknown or is indeterminable.

As noted elsewhere, if the AFB is demonstrated effective at the Contra Costa Power Plant during Phase I, it would be implemented at the Pittsburg Power Plant during Phase II. The potential impacts set forth in Tables 3-17, 3-18 and 3-19, are expected to be reduced by 80-99 percent. If, however, the AFB is not demonstrated effective during Phase I, such technology would not be deployed at the Pittsburg Power Plant during Phase II and the Contra Costa Power Plant would implement VSD Flow Minimization and discontinue AFB.

Sensitive Fish Species Monitoring. For VSD Flow Minimization, the abundance of the eight sensitive fish species identified in this HCP will be documented during on-site entrainment studies to be conducted at the Contra Costa Power Plant. The entrainment monitoring will be done annually from May through mid-July in conjunction with a striped bass monitoring program conducted under the jurisdiction of the CDFG. Because sensitive species monitoring will occur concurrently with the existing striped bass monitoring program, the additional take of listed species will be minimized. Both USFWS and CDFG have expressed concern that other current Delta smelt monitoring programs may already be taking too many fish and that it is unlikely that any additional monitoring will be permitted. The specifics of the sampling program are provided in Section 3-2.10.1. Results from this monitoring related to the sensitive fish species will be used to verify the take of these species in entrainment samples collected during the May 1-July time period. The following threshold and reporting standards will be followed for VSD.

A. Threshold—VSD

Sensitive fish species will be sampled using standard ichthyoplankton nets at both of the power plant discharge sites, and data will be reported as total number collected during the sampling period and as catch/unit effort. The take of sensitive species during this monitoring effort is expected to be minimal based on previous years' results, primarily because of the small volume of water sampled each year (0.006 % of flow through the plant), and the low abundance of the sensitive species. The results of these sampling efforts will be used to improve the understanding of the plants impacts and to provide information for future refinement of minimization measures.

The following take limit threshold will apply for the only species currently with endangered status (winter-run chinook salmon). No winter-run chinook salmon are expected to be collected during this effort. If a winter-run salmon is collected, the sampling will be discontinued and USFWS, NMFS and CDFG will be notified immediately. The agencies may allow sampling to resume following notification. The specifics of the monitoring program are described in detail in Section 3-2.10.1.

B. Reporting—VSD

Monitoring data on the sensitive fish species collected during the entrainment sampling will be submitted in an annual report by January 31.

The following monitoring will be implemented for AFB usage. If the AFB is not effective at Contra Costa Power Plant in Phase I, then the sampling program will remain the same as set forth above. The abundance of the eight sensitive fish species identified in this HCP will be documented during a limited time (one to three year), intensive on-site entrainment study in accordance with a biological monitoring and sampling program as set forth in Appendix H. The entrainment monitoring will be performed from February through July.

Results from this monitoring related to the sensitive fish species will be used to determine the efficacy of the AFB technology in preventing entrainment of HCP species. Sampling will be conducted as set forth both inside and outside the AFB. The biological sampling program may be refined in consultation with a technical team comprised of representatives of the USFWS, NMFS, and CDFG. Should the AFB be determined effective, it is expected that sampling will be reduced in order to lessen the take and impact to sensitive species.

C. Threshold—AFB

Sensitive fish species will be sampled using standard ichthyoplankton nets at both of the power plant discharge sites and by push nets, and data will be reported as total number collected during the sampling period and as catch/unit effort. The take of sensitive species during this monitoring effort is expected to be minimal based on previous years' results, primarily because of the small volume of water sampled and the low abundance of the sensitive species. The results of these sampling efforts will be used to improve the understanding of the effectiveness of the AFB under various conditions and the plant's impacts and to provide information for future refinement of minimization measures.

The following take limit threshold will apply for the only species currently with endangered status (winter-run chinook salmon). No winter-run chinook salmon are expected to be collected during this effort. If a winter-run salmon is collected, the USFWS, NMFS and CDFG will be notified immediately and SE would undertake consultation with such agencies to determine the whether and how to conduct continued sampling. The specifics of the monitoring program are described in detail in Section 3-2.5.

D. Reporting—AFB

Monitoring data on the sensitive fish species collected during the entrainment sampling will be submitted in an annual report by January 31.

3-2.9.2 Impingement

Impingement occurs when an organism is held against the intake screens used to remove debris from the cooling water. Fish susceptible to impingement are typically either small juveniles (typically greater than 38 mm long) or large juveniles and adults that are in a weakened condition or have died from other causes. The survival of impinged fish depends on the species, life stage, and size of the organism. Other factors influencing impingement survival include the duration of impingement and the techniques of handling impinged organisms and returning them to the water body, as well as seasonal water body characteristics, such as salinity, water temperature, etc. For the purposes of this document, it is assumed that no impinged organisms survive to be returned to the receiving waters.

Studies conducted in 1978 and 1979 (Ecological Analysts, Inc. 1981b) provide estimates of Delta smelt, longfin smelt, Sacramento splittail, chinook salmon, steelhead, and green sturgeon impinged at the circulating water intake structures at Contra Costa Power Plant (Table 3-20). Unlike entrainment monitoring where a relatively small volume of circulating water is sampled, impingement samples reflect the total volume of circulating water for each collection effort.

Because most of the species listed in Table 3-20 have experienced significant declines in their populations over the past 20 or more years, a potential current impingement column has also been included. Adjustment factors presented for Delta smelt, longfin smelt, and splittail were available from published literature and were fully described in the previous section, and the reduction factor for winter-run salmon is described later in this section. Current potential impingement estimates for fall/late fall-run chinook salmon were not calculated because this population is believed to be at or near its historical level (U.S. Fed. Reg. Vol. 63, No. 45/Monday, March 9, 1998) and although spring-run chinook salmon was listed as state threatened in February 1999, no published reduction estimates could be found in the literature; consequently, no adjustment factor was available. Also, no adjustment factors could be found in the available literature for either steelhead or green sturgeon and consequently no adjustment factors are presented for them either.

Table 3-20. Total Number of Fish Collected during Impingement Sampling, Estimated Annual Impingement at Contra Costa Power Plant at Units 1-7 for April 1978-April 1979, and Potential Current Impingement at Full Design Flow of Circulating Water Volumes

FISH SPECIES IMPINGED	Number of fish collected[1]	1978-1979 Impingement[2]	Reduction Factor	Potential Current Units 1-7 Impingement[3]
Delta smelt	1,747	8,253 ± 1,595	90%[4]	825
Longfin smelt	1,275	19,475 ± 11,758	90%[5]	1,950
Osmeridae	0	0	None	0
Sacramento splittail	1,792	12,455 ± 3,422	62%[6]	4,750
Winter-run chinook salmon	12 of 176	53 of 763 ± 22	93%[7]	4
Spring-run chinook salmon	63 of 176	275 of 763 ± 114	None[8]	275 of 763 ± 114
Fall/late fall-run chinook salmon	174 of 176	755 of 763 ± 313	None[9]	755 of 763 ± 313
Steelhead	1	38 ± 39	0	38 ± 39
Green sturgeon	1	0	0	0

[1] Represents total number of fish collected during study period.
[2] Estimates based on impingement densities (April-December 1978 and from January-April 1979) and include 95% confidence interval.
[3] Estimates represent maximum potential based on design flow of Units 1-7; actual flows are less.
[4] Federal Register Volume 58, No. 49/ Tuesday, March 16, 1993.
[5] **Sacramento/San Joaquin Delta Native Fishes Recovery Plan**, USFWS, 1996
[6] Federal Register Volume 64, No. 25/Monday, February 8, 1999.
[7] Reduction based on analysis presented in Section 3-2.9.2 of HCP; a reduction estimate of 99% between 1966 and 1991 was presented in **Recommendations for the Recovery of the Sacramento River Winter-Run Chinook Salmon**, March 9, 1996, by the Sacramento River Winter-Run Chinook Salmon Recovery Team.
[8] No adjustment values for this species could be found in the literature; therefore, it was left uncorrected.
[9] This run was reported in the Federal Register Volume 63, No. 45/Monday, March 9, 1998, to be at or near historical levels; consequently, no reduction factor is necessary.

Even though individual lengths of the chinook salmon collected during the 316(b) impingement studies were not available, monthly length ranges were recorded in Appendix E of the "Cooling Water Intake Structure 316(b) Demonstration" (Ecological Analysts, Inc. 1981b). The monthly totals for the fish collected during the 1978-79 impingement sampling, and the categories for the different run types are shown in Table 3-21.

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Table 3-21. Total and Maximum Number of Chinook Salmon Collected, by Run Categories[1], during Impingement Sampling for Units 1-7 at the Contra Costa Power Plant (April 1978 - January 1980) Based on Length and Month of Capture

MONTH/YEAR	Actual number collected	Maximum number collected by run category		
		Winter -run	Spring-run	Fall/late fall-run
APR 78	15	-	14	15
MAY 78	12	-	-	12
JUN 78	41	-	-	41
JUL 78	0	-	-	-
AUG 78	0	-	-	-
SEP 78	0	-	-	-
OCT 78	0	-	-	-
NOV 78	2	-	-	2
DEC 78	5	4	-	5
JAN 79	1	1	-	1
FEB 79	3	2	1	2
MAR 79	5	4	4	4
APR 79	6	-	5	6
MAY 79	16	-	15	16
JUN 79	25	-	24	25
JUL 79	12	-	-	12
AUG 79	0	-	-	-
SEP 79	1	-	-	1
OCT 79	4	-	-	4
NOV 79	25	-	-	25
DEC 79	2	-	-	2
JAN 80	1	1	-	1
TOTAL/MA...	176	12	63	174
PERCENT		7%	36%	99%

[1] This table is based on Table B-5 of Appendix B. The number shown under each of the runs is the maximum number possible based the analyses of Frank Fisher of CDFG (1991 unpublished data).

For winter-run, a worst-case maximum of 7% of the fish fall into the winter-run category. Therefore, worst-case annual impingement of winter-run based on 1978-79 abundances would have been 7% of 763 fish, or 53 total fish. If the average of 1978 and 1979 adult winter-run counts (23,669 and 2,251 = 25,920) is compared with the average 1995 and 1996 winter-run counts (1,296 and 527 = 1,823), the predicted 1995 and 1996 impingement estimate would be 7% of the 1978-79 total, or 4 winter-run smolts. For the spring and fall/late fall runs, the worst case impingement of the different run types in 1978-79 would have been 275 and 755 chinook salmon, respectively. (For Units 6&7 only, these values would have been 9, 158, 295 chinook salmon for the winter, spring, and fall/late fall runs, respectively.) The decreases in abundance between 1978-79 and 1995-96 for the spring and fall/late fall-runs were less extreme than for winter-run, so the adjusted values were not calculated for the other runs. The worst-case estimates add up to a value greater than the total estimated number because an unknown percentage of these fish fall into more than one of the run categories.

The estimates provided in Table 3-20 are for all of the existing operating units at the time of the impingement studies (1978-1979), and are a combination of separate impingement estimates for both intake systems for Units 1-5 and Units 6&7. Currently, Units 1-3 are retired. Units 4&5 are currently operated as synchronous condensers, which do not require cooling water from circulating water pumps for condensers. Therefore, a more accurate estimate of present day impingement based on the 1978-79 studies includes only the impingement estimates for Units 6&7. As Unit 8 is proposed to use the discharged cooling water from Units 6 & 7, there would be no incremental increase in impingement caused by the proposed Unit 8. These values and potential current impingement levels are provided in Table 3-22. Salmon impingement by month and run category is presented in Table 3-23.

For Delta smelt, longfin smelt, splittail, and chinook salmon, the estimated annual impingement with only Units 6&7 operating were reduced by 75%, 95%, 51%, and 61%, respectively, compared to operation of all the units (Units 1-7) (Tables 3-20 and 3-22).

Impingement monitoring was also performed at circulating water intakes from 1987 through 1990. In general, the impingement sampling was done once a month from August through February. The number of Osmeridae, Delta smelt, longfin smelt, Sacramento splittail, chinook salmon, steelhead, and green sturgeon collected in impingement samples during each of these periods is summarized in Table 3-24. Based on the estimates provided in Table 3-24, impingement of Delta smelt and chinook salmon during the August through February time period appears to be minimal.

Table 3-22. Total Number of Fish Collected during Impingement Sampling, Estimated Annual Impingement at Contra Costa Power Plant at Units 6 and 7 for April 1978-April 1979, and Potential Current Impingement at Full Design Flow of Circulating Water Volumes

Fish Species Impinged	Number of Fish Collected[1]	1978-1979 Impingement[2]	Reduction Factor	Potential Current Impingement[3]
Delta smelt	363	2,064 ± 529	90%[4]	200
Longfin smelt	135	962 ± 625	90%[5]	100
Osmeridae	0	0	None	0
Sacramento splittail	946	6,066 ± 1,919	62%[6]	2,300
Winter-run chinook salmon	2 of 80	9 of 298 ± 4	93%[7]	>1
Spring-run chinook salmon	42 of 80	158 of 298 ± 70	None[8]	158 of 298 ± 70
Fall/late fall-run chinook salmon	79 of 80	295 of 298 ± 131	None[9]	295 of 298 ± 131
Steelhead	0	0	0	0
Green sturgeon	0	0	0	0

1 Represents total number of fish collected during study period.
2 Estimates based on impingement densities (April-December 1978 and from January-April 1979) and include 95% confidence interval.
3 Estimates represent maximum potential based on design flow Units 6 & 7 actual flows are less.
4 Federal Register Volume 58, No. 49/ Tuesday, March 16, 1993.
5 **Sacramento/San Joaquin Delta Native Fishes Recovery Plan**, USFWS, 1996.
6 Federal Register Volume 64, No. 25/Monday, February 8, 1999.
7 Reduction based on analysis presented in Section 3-2.9.2 of HCP; a reduction estimate of 99% between 1966 and 1991 was presented in **Recommendations for the Recovery of the Sacramento River Winter-Run Chinook Salmon**, March 9, 1996, by the Sacramento River Winter-Run Chinook Salmon Recovery Team.
8 No adjustment values for this species could be found in the literature; therefore, it was left uncorrected.
9 This run was reported in the Federal Register Volume 63, No. 45/Monday, March 9, 1998, to be at or near historical levels; consequently, no reduction factor is necessary.

Table 3-23. Total and Maximum Number of Chinook Salmon Collected, by Run Categories[1], during Impingement Sampling for Units 6 & 7 at the Contra Costa Power Plant (April 1978 - January 1980) Based on Length and Month of Capture

MONTH/YEAR	Actual number collected	Maximum Number Collected by Run Category		
		Winter -run	Spring-run	Fall/late fall-run
APR 78	13	-	12	13
MAY 78	10	-	-	10
JUN 78	10	-	-	10
JUL 78	0	-	-	-
AUG 78	0	-	-	-
SEP 78	0	-	-	-
OCT 78	0	-	-	-
NOV 78	0	-	-	-
DEC 78	0	-	-	-
JAN 79	0	-	-	-
FEB 79	3	2	1	2
MAR 79	1	-	-	1
APR 79	3	-	2	3
MAY 79	14	-	14	14
JUN 79	14	-	13	14
JUL 79	9	-	-	9
AUG 79	0	-	-	-
SEP 79	0	-	-	-
OCT 79	0	-	-	-
NOV 79	3	-	-	3
DEC 79	0	-	-	-
JAN 80	0	-	-	-
TOTAL/MAX.	80	2	42	79
PERCENT		3%	53%	99%

[1] This table is based on Table B-6 of Appendix B. The number shown under each of the runs is the maximum number possible based the analyses of Frank Fisher of CDFG (1991 unpublished data).

Table 3-24. Total Number of Fish Collected during the 1987-1990 Sampling Period and the Estimated Average August-February Impingement for Units 1-7 at the Contra Costa Power Plant.[1]

FISH SPECIES IMPINGED	Total number of fish collected from 1987-1990.[2]	Estimated average August-February impingement.[3]
Delta smelt	18	549 ± 1,239
Longfin smelt	7	214 ± 1,031
Osmeridae	0	0
Sacramento splittail	17	519 ± 1,246
Winter-run chinook salmon	0	0
Spring-run chinook salmon	0	0
Fall/late fall-run chinook salmon	0	0
Steelhead	0	0
Green sturgeon	0	0

[1] Data collected from August 1 - February 28 each year.
[2] Represents total number of fish collected during the 3-year study period.
[3] Estimated impingement based on densities established in August-February sampling and scaled linearly to design flow Units 1-7, and includes 95% confidence intervals.

The estimates provided in Table 3-24 are for all of the existing operating units at the time of the impingement studies (1987-1990), and are a combination of separate impingement estimates for both intake systems for Units 1-5 and Units 6&7. Currently, Units 1-3 are retired. Units 4&5 are currently operated as synchronous condensers, which do not require cooling water from circulating water pumps. Therefore, a more accurate estimate of present day impingement based on the 1987-1990 studies includes only the impingement estimates for Units 6&7. As Unit 8 is proposed to use the discharged cooling water from Units 6 & 7, there would be no impingement increase caused by Unit 8. These values are provided in Table 3-25.

Table 3-25. Total Number of Fish Collected during the 1987-1990 Sampling Period and the Estimated Average August-February Impingement for Units 6&7 at the Contra Costa Power Plant[1]

FISH SPECIES IMPINGED	Total number of fish collected from 1987-1990[2]	Estimated average August-February impingement[3]
Delta smelt	9	181 ± 331
Longfin smelt	6	121 ± 416
Osmeridae	0	0
Sacramento splittail	16	342 ± 609
Winter-run chinook salmon	0	0
Spring-run chinook salmon	0	0
Fall/late fall-run chinook salmon	0	0
Steelhead	0	0
Green sturgeon	0	0

[1] Data collected from August 1 - February 28 each year.
[2] Represents total number of fish collected during the 3-year study period.
[3] Estimated impingement based on densities established in August-February sampling and on design flow of Units 6 & 7 for a 7-month period, and includes 95% confidence intervals.

For Delta smelt and longfin smelt, the estimated impingement was reduced by 67% and 44%, respectively, with only Units 6&7 operating compared to operating all units (Units 1-7) (Tables 3-24 and 3-25).

The relative proportion of fish impinged to those entrained at Contra Costa Power Plant was very small, as illustrated by comparing Tables 3-22 and 3-25 to Tables 3-16 and 3-18, respectively. The total percentage of Osmerids (to simplify the analysis, all Delta smelt, longfin smelt and *Osmeridae* were combined because the vast majority of fish originally entrained could only be identified to *Osmeridae*) impinged compared to entrained in the 1978-79 studies was only 0.05% and for the 1986-92 entrainment/1987-90 impingement studies was 0.2%. The percentage of Sacramento splittail impinged compared to entrained in the 1978-79 studies was 4.6% and in the 1986-92 entrainment/1987-90 impingement studies was only 0.3%. No winter-run or spring-run chinook salmon were collected in either the 1978-79 and 1986-92 entrainment studies or the 1987-90 impingement study, but the estimated annual numbers of winter-run and spring-run impinged were 9 and 158, respectively, in the 1978-79 study for Units 6&7. Because the populations of many Delta species have changed since these data were originally collected, the percentages presented above may not reflect current conditions.

Impingement on the existing intake screens is expected to be completely eliminated by use of the AFB and impingement on the AFB itself should be minimal. The approach velocity for the AFB is anticipated to be approximately 0.02 ft/sec. Approach velocities will be periodically measured as set forth in the Biological Monitoring and Sampling Program described in Appendix H. Laboratory studies will be undertaken to estimate impingement impacts of the AFB.

3-2.9.3 Thermal Effects

Potential effects associated with exposure to power plant thermal discharge plumes include behavioral avoidance of potential habitat, behavioral attraction, increased susceptibility to predation, sublethal stresses resulting in reduced health and fitness, and potential acute mortality as a consequence of exposure to elevated temperatures. The response of a fish species to the thermal discharge plume varies depending on the thermal tolerance and physiology of the species, its life stage, acclimation temperature, the duration of exposure, the difference in temperatures between the acclimation temperature and the exposure temperature (delta-T), and the absolute temperature to which the organisms are exposed. Factors such as the geographic distribution of the thermal plume, the vertical distribution of the plume within the water column, mixing characteristics, the thermal dissipation (temperature decay), and the configuration and characteristics of discharge are important factors affecting the potential biological significance of exposure to the discharge.

In 1990, the Regional Water Quality Control Board, CDFG, and NMFS required PG&E to conduct a study of thermal effects on fisheries found in the vicinity of the power plant. A thermal effects assessment was conducted in 1992 (PG&E 1992). The assessment consisted of intensive water temperature monitoring of the cooling water discharge and receiving waters coupled with monthly fisheries surveys at locations in and out of the discharge plume. The study addressed general fish use in the vicinity of the discharges, direct mortality of fish and macroinvertebrates, fish condition (i.e., striped bass length/weight analysis), abnormalities and infection, susceptibility to predation, behavioral attraction and avoidance, and migration blockage. In addition, the assessment specifically addressed species of special interest, which included delta smelt, longfin smelt, Sacramento splittail, and juvenile chinook salmon. These special interest species are the major target fish species of the HCP. The results of the study showed that the discharge had no adverse impact on any of the anadromous fish or other aquatic species (including the HCP target species) inhabiting the area, and that beneficial uses were protected.

In addition, in 1995, as described in the Waste Discharge Requirements Order No. 95-234 issued to the Contra Costa Power Plant, the Regional Water Quality Control Board found the thermal effluent discharge limitations adequate to ensure protection of the beneficial uses of the receiving water.

No significant differences in thermal effects are expected to result if AFB technology is deployed during Phase II. The recirculation of the heated plume into the cooling water intake may be reduced and the plume may be directed farther out into the river when the river is flowing westward due to the AFB's presence. Due to increased velocity in this area, the thermal mixing zone should be reduced in size.

3-2.9.4 Impact Summary and Comparison

As described in the three previous subsections, operation of the power plants circulating water system has the potential to impact aquatic organisms of the Delta through entrainment, impingement, and exposure to elevated water temperatures within the thermal discharge plume. Based on the 1978-1979 316(b) studies (Ecological Analysts, Inc. 1981b), entrainment accounted for 99.8% of the total combined number of fish estimated to be entrained and impinged on an annual basis (target fish species at design flow). The most recent thermal effects studies conducted in 1991-1992 (PG&E 1992) concluded that the discharge had no adverse impacts on any of the target aquatic species covered by this HCP. Based on these results, it was concluded that the potential entrainment of aquatic organisms is the single most important impact of the operation of the power plants circulating water system.

Entrainment is directly affected by the density of the aquatic organisms in the water being drawn into the power plant and the degree to which the power plant is operated. The 1978-1979 entrainment studies were conducted when most of the target species were much more abundant than they are now. Populations of some of these species, such as Sacramento splittail and Delta smelt have decreased by about 60 to 90% since these studies were originally conducted (see Section 3-2.4.1). The second factor in determining entrainment levels is how much circulating water is being used by the power plant. Although it is not possible to predict future powerplant operations, historical average monthly flows for February through July 1986-1999, varied between 37 to 72% and averaged 57% of the power plant design level (Appendix E, Table E-2). Predicting current potential entrainment estimates using a combination of reduced population estimates and average historical flow levels would result in about an additional 40% decrease in the potential current entrainment amounts than shown in Table 3-16 for Sacramento splittail and Delta smelt.

Implementation of VSD Flow Minimization, 95% of Unit 6 & 7 design flow usage at CCPP should result in at least a 5% reduction from the entrainment amounts in Table 3-16. Implementation of AFB may result in an 80-99% reduction from the entrainment amounts in Table 3-16.

The most recent entrainment studies, 1986 to 1992, were conducted during one of the longest periods of reduced precipitation and Delta outflow in recent history. This decreased Delta outflow, as represented by the location of X2 (X2 calculated with equations developed by Kimmerer and Monismith 1992), is depicted in Figure 3-16 for the years 1980 to 1996. Only the period of May 1 to July 15 is shown here because this was the same general period that the 1986-1992 entrainment studies were conducted. As this figure shows, the location of X2 was at or between the Pittsburg and Contra Costa power plants (middle figure) for the vast majority of the time (approximately 80%) than for either the six year period before 1986 (upper figure, 40%) or the four year period following the study period end of 1992 (lower figure, 25%).

As previously discussed in Section 2-3.0, Delta smelt may be expected to exhibit a higher probability of entrainment in low outflow years (IEP 1996) when X2 is located nearer the power plants than in high outflow years when X2 is located below the power plants. If this is true, then it would be expected that the power plants would entrain greater numbers of Delta smelt during this period than either before (pre 1986) or after (post 1992). Unfortunately, no data was collected in either of these periods to be able to verify this assumption, but as shown in Table 3-18, only a total of 4 Delta smelt were collected at the power plant (Units 6&7) during the 1986-1992 study period. Of these, two were classified as larvae (less than ~ 15 mm in length) and the other two were classified as juveniles (greater than ~16 mm in length). These 4 fish were extrapolated by using the SIMBAS computer model to an estimated 16,003 (9,695 larvae and 6,308 juvenile) fish being entrained, as shown in Table 3-19, for all of the 1986-1992 sampling efforts combined.

Any comparison of entrainment impacts between Contra Costa Power Plant and the CVP and SWP, the two largest water diverters in the Delta, is limited due to differences in the size classes of Delta smelt typically collected (or salvaged) and monitoring periods between these facilities. Between 1986 to 1992, the CVP and SWP salvaged more than 135,000 Delta smelt greater than 20 mm in length (based on the expanded salvage records of the IEP for the Sacramento-San Joaquin Estuary, CDF&G, Stockton, CA) for the May 1- July 15 period, as illustrated in Figure 3-17. During this same period, sampling at the power plant (Units 6&7) resulted in collecting two juvenile Delta smelt, estimated entrainment of 6,308, and two juvenile Osmerids, estimated entrainment of 9,428, for a combined total estimated entrainment of 15,736 juvenile smelt. Even if both of the Osmerids collected were Delta smelt, this would result in a ratio of the combined number of salvaged Delta smelt from the CVP and SWP to the power plant at 8:1 for this time period. In the latter three years of the study period, 1990-1992, when it was possible to identify all collected juvenile Osmerids to species, the ratio of the combined number of salvaged Delta smelt from the CVP and SWP (39,777) to the estimated number entrained at the power plant (6,308 for Units 6&7) at [illegible].

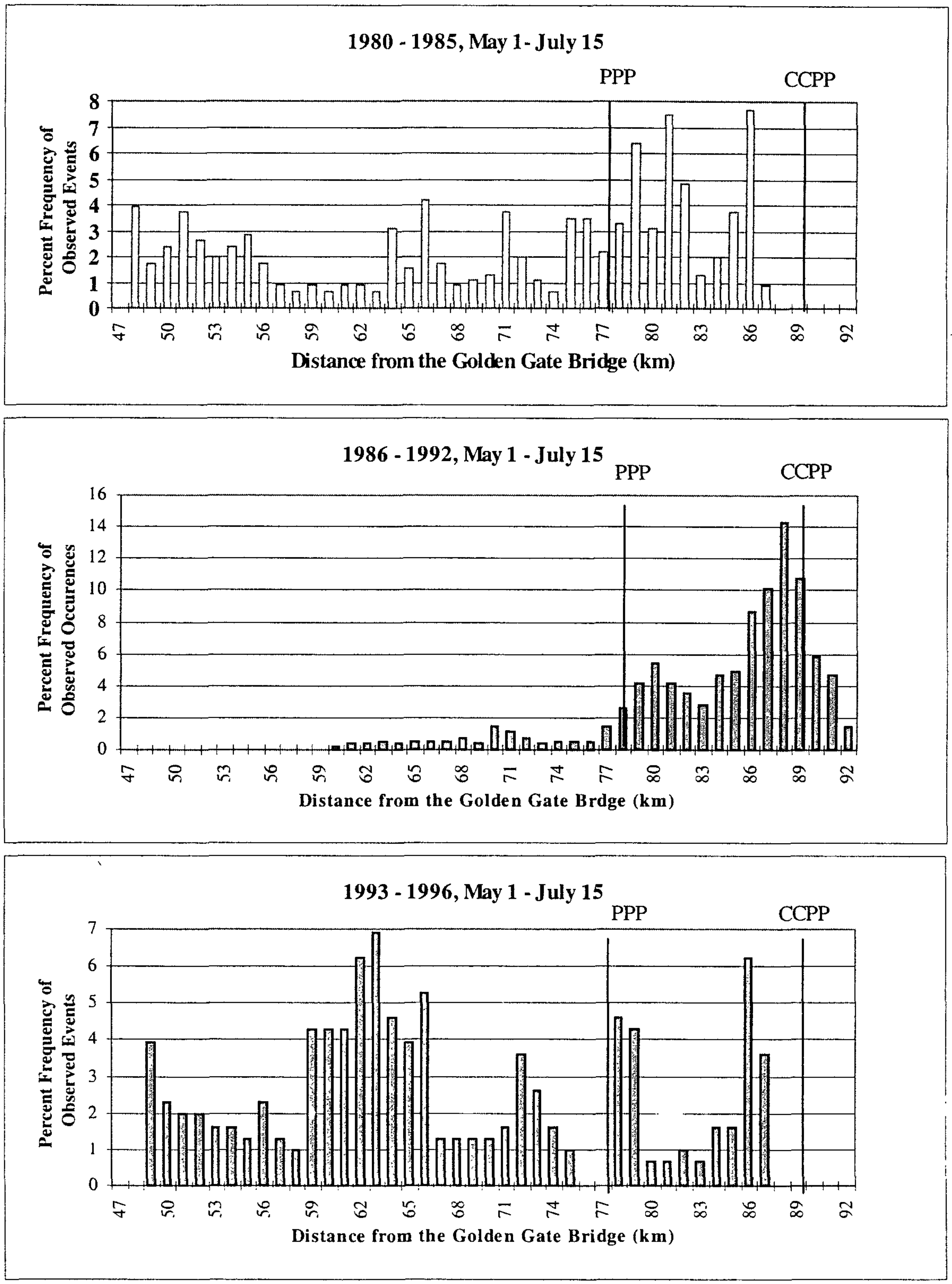


Figure 3-16. Relative frequency distribution histograms for the average location of X2 to the Pittsburg Power Plant (PPP) and the Contra Costa Power Plant (CCPP) for May 1 - July 15, 1980 - 1996.

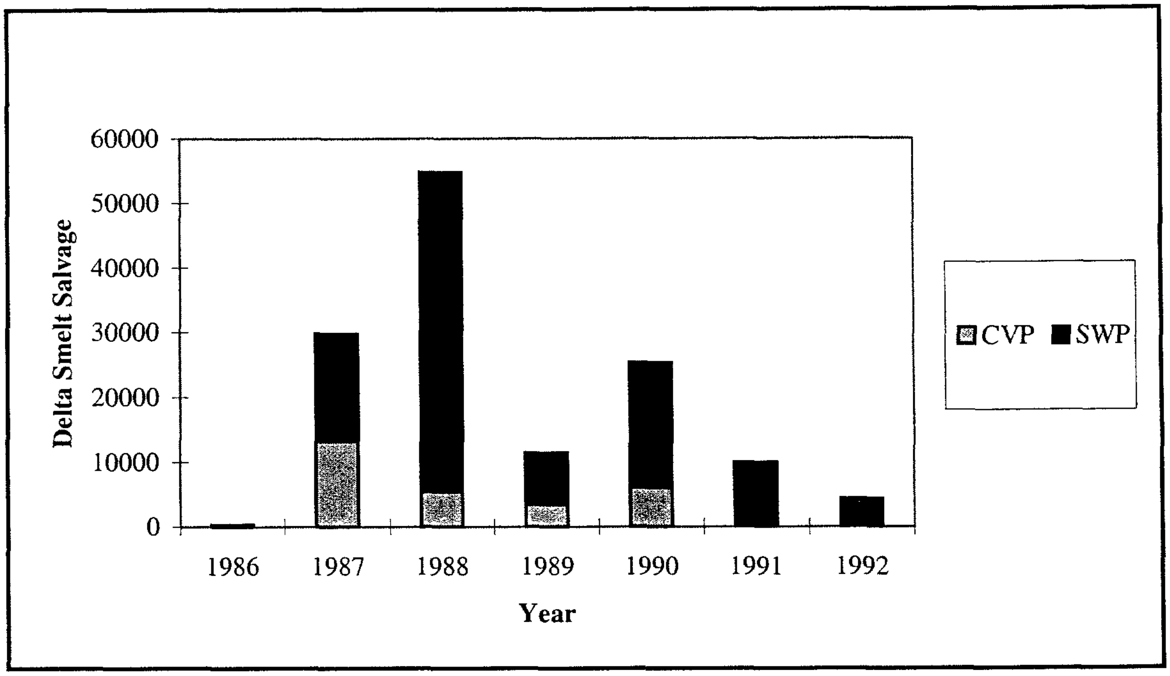


Figure 3-17. Total CVP and SWP juvenile (≥ 20 mm) Delta smelt salvage for May 1 - July 15, 1986-1992. (Data based on expanded salvage estimates from IEP for the Sacramento-San Joaquin Estuary, CDF&G, Stockton, CA)

Comparison of impacts on larval Delta smelt between Contra Costa Power Plant and CVP and SWP is more problematic because monthly sampling for larval fish are not routinely conducted at the water projects. Annual entrainment loss estimates for larval Delta smelt for the CVP and SWP were presented by USFWS (1995) for the period of 1989 to 1992 (1989 = 579,113; 1990 = 931,246; 1991 = 40,986 [note, no sampling conducted from April 17 to May 27, 1991]; and 1992 = 1,199,903) and totaled 2,751,248. Annual entrainment estimates for Units 6&7 at the Contra Costa Power Plant are not possible because data was only collected for a 2 ½ month period between May 1 to July 15 of these years. During this period only two Delta smelt larvae were collected resulting in an estimated entrainment of 9,695 as well as 126 larval Osmerids with an estimated entrainment of 351,873. It is unknown how many of these Osmerids may have been Delta smelt. Because the peak period for larval Osmerid abundance at the power plant, based on the 1978-1979 study (Ecological Analysts, Inc. 1981b), occurs in February and March, these estimates are probably several times less than the actual annual entrainment levels. Consequently, it is not possible to directly compare larval entrainment estimates between the power plant and the CVP and SWP.

Distribution, and hence densities, of larval fish are highly affected by Delta hydrology. The Contra Costa Power Plant (Units 6&7) uses up to a maximum of 680 cfs of Delta waters in its circulating water system. Unit 8 will reuse up to 17 cfs of the Unit 6 & 7 discharge. However, nearly all of this water is immediately returned back to the Delta (being replaced by water that is already present in the plants circulating water system, less the evaporation from Unit 8 cooling tower that varies from 0 to 6 cfs), so there is no net effect on the hydrology of the Delta. Conversely, the CVP diverts up to 4,600 cfs and the SWP generally diverts up to 6,400, but at times an additional 3,900 cfs (SWP total 10,300 cfs) of San Joaquin flow can also be diverted, which is exported out of the Delta, directly affecting the hydrology of the system. This diversion can result in a reduction of both total outflow and high spring outflow. These reductions can affect the location of the mixing zone, river flow direction, primary productivity, and survival of larval and juvenile fish (Moyle et al 1992; Sweetnam and Stevens 1993). During periods of high export pumping by the CVP and SWP, and low to moderate outflows, portions of the San Joaquin River and other channels can reverse directions, and flow toward the pumping plants. During periods of reverse, or negative outflow, out-migrating larval and juvenile fish of many species become disorientated and are carried upstream to the pumping plants where they become entrained or are preyed on by striped bass or other predators at the various pumping and water diversions. In addition, 1,800 local private water rights holders throughout the Delta also divert an additional 3,000 to 4,000 cfs during the peak irrigation season, resulting in additional fish losses (USFWS 1995).

In summary, when the same size classes of fish (i.e., juvenile Delta smelt) are compared over the same time period between the power plant and the CVP and SWP, the power plant has a lesser estimated entrainment level than the estimated salvage level for the water projects. Even when combined with the estimated entrainment form the Pittsburg Power Plant of 25,194 juvenile Delta smelt (see Section 3-2.4.4), the total estimated entrainment of the two power plants, 31,492, is still less that for the CVP and SWP, 39,777. Also, operation of the power plants either alone or in combination has very little effect on the hydrology of the Delta; nearly all the water circulated through the power plants is returned to the Delta. Conversely, the CVP and SWP export large amounts of water, resulting in various impacts, including changes in: seasonal outflow amounts, timing and duration of high spring flows, the location of the mixing zone, river flow direction, primary productivity, export of larval fish, and survival of larval and juvenile fish that remain in the Delta. Based on the power plants location in a much broader section of the Delta and downstream of the primary spawning areas of the Delta smelt, longfin smelt, and other target species of the HCP than either the CVP and SWP, operation of the power plants would be expected to have less of an impact on year class strength of these species. Nonetheless, implementation of VSD Flow Minimization and, particularly, AFB should it be demonstrated effective, should result in a substantial overall decrease in the impact of the Contra Costa Power Plant on HCP species.

3-2.10 Other Impacts

3-2.10.1 Striped Bass Monitoring Program

A. Activities

The Entrainment Abundance Sampling Program is designed to provide information on the relative abundance and temporal distribution of larval and juvenile striped bass susceptible to entrainment at the Contra Costa Power Plant between May 1 and July 15, or the date that CDFG predicts that the 38-mm striped bass is to be set, whichever is earlier. This program actually consists of two related monitoring programs: a Threshold Monitoring Program and an Entrainment Abundance Monitoring Program. The program for July 1999 is described in NPDES Permit CA0004863 from the California Regional Water Quality Control Board Central Valley Region and the **Agreement between the Pacific Gas and Electric Company and the California Department of Fish and Game for the Monitoring and Mitigation of Striped Bass in the Sacramento-San Joaquin Estuary** (PG&E 1995). The monitoring is conducted annually unless waived by mutual consent of the permittee and CDFG. Specific details of the sampling program are discussed below.

Samples of entrained organisms are collected by filtering water pumped from each designated power plant discharge gate well with a 4-in diameter recessed-impeller pump (Home-lite Trash Pump). Entrainment samples are preferentially collected from either Contra Costa Unit 6 or Unit 7 with 4-in PVC sampling pipes. Because of fluctuations in operation of specific units at the power plant, on rare occasions it has been necessary to collect samples from Contra Costa Units 1-5 to ensure continuity of monitoring.

All sampling pipe intakes are directed into the circulating water flow from a location in the center of each discharge conduit. Because of turbulence and through-plant mixing, organisms are expected to be distributed more uniformly at the discharge than at the intake. This conclusion is based on special intake-discharge mass balance studies that were conducted as part of the 316(b) studies (Ecological Analysts, Inc. 1981b) for the Unit 7 intake and discharge in 1978-1979. Data collected was statistically analyzed and based on the results, it was concluded that: 1) there was no significant loss of organisms passing through the cooling water system; 2) the cooling water at the discharge was more thoroughly mixed than at the intake; and 3) the discharge was the better location for sampling entrainment abundance. To provide continuity of protocol all sampling pipe intakes have been modified to consist of a series of 6 horizontally spaced 3/8-in X 1-1/8-in deep slots. The velocity in the sampling inlet exceeds the cooling water flow velocity, thereby preventing any back pressure around the inlet that might reduce efficient organism collection.

The entrainment sampling pump discharges into either of two 0.5-m diameter plankton nets with 0.5-mm mesh suspended in a 3-ft high by 3-ft wide cylindrical polyethylene tank. Sample volume and flow rate are measured with an annually calibrated Sparling inline flow meter mounted in the sampling pump discharge line. The flow rate during sampling is maintained at approximately 0.9 to 1.0 cubic meter/minute. This results in sampling approximately 180 or 720 cubic meters of cooling water per 3- or 12-hour sampling effort, respectively.

The plankton nets are cycled at 30-minute intervals throughout either the 3- or 12-hour sampling efforts (threshold and entrainment abundance, respectively) to minimize problems of net clogging and/or abrasion and mutilation of collected organisms. The sample is then collected by rinsing the net from the outside, concentrating the organisms in a screen-walled collection container (codend). Samples are then decanted into either a 1-pint or 1-quart glass jar, preserved with either 70% isopropanol alcohol or 10% formaldehyde, and stained with rose bengal dye for subsequent processing (described below).

Each entrainment sample is sorted using a magnifying illuminator and/or dissecting microscope to remove fish larvae and eggs. Striped bass eggs and larvae are identified, counted, and the total length of larvae are measured to the nearest millimeter using a calibrated ocular micrometer. All other fish are identified to species when possible. Following identification and measurement, fish eggs and larvae are placed in labeled vials and archived. Archived samples are generally discarded after 1-year with CDFG and CRWQCB approval. Species of special concern will be stored in separate vials with 10% formaldehyde and delivered to CDFG at the end of each monitoring season.

All sample collection, processing operations, and taxonomic identifications are performed by trained personnel and are subject to strict quality assurance standards established for this program. Standardized sample collection and processing voiding criteria are applied in the monitoring program. Results of quality assurance checks on sample collection, sample processing resorts, and taxonomic verification are maintained in onsite logs. Sample collection and processing activities and associated data logs are periodically inspected by representatives of CDFG.

B. Impacts

Sampling may result in the pursuit, capture, harassment, harm and death of Delta smelt, longfin smelt, Sacramento splittail, chinook salmon, steelhead, and green sturgeon. Based on sampling approximately 35 acre-feet of water annually (as described above) over the term of the permit (15 years), take of these species could reach the following levels in Table 3-26. The number of Delta and longfin smelt were calculated by proportioning the number of Osmeridae (unidentified smelt) from Table 3-6, based on the ratio of identified Delta smelt to longfin smelt over the 7-year sampling period, and then adding them to the average number of Delta smelt and longfin smelt collected over the 7 years. Specifically, 4/10 of the average May-July number of Osmerids (18.28) extrapolated to 15 years (274) were considered to be Delta smelt and 6/10 were considered to be longfin smelt.

Table 3-26. Anticipated Take of Acre-feet of Water and Estimated Numbers of Individuals during the Striped Bass/Sensitive Species Monitoring Program at the Contra Costa Power Plant for the 15-Year Permit Period

SPECIES	Anticipated take
Delta smelt	The number of individuals supported by 525 acre-feet of water, estimated to be 118 individuals
Longfin smelt	The number of individuals supported by 525 acre-feet of water, estimated to be 178 individuals
Sacramento splittail	The number of individuals supported by 525 acre-feet of water, estimated to be 17 individuals
Winter-run chinook salmon	The number of individuals supported by 525 acre-feet of water, estimated to be between 0-15 individuals
Spring-run chinook salmon	The number of individuals supported by 525 acre-feet of water, estimated to be between 0-15 individuals
Fall/late fall-run chinook salmon	The number of individuals supported by 525 acre-feet of water, estimated to be between 0-15 individuals
Steelhead	The number of individuals supported by 525 acre-feet of water, estimated to be between 0-15 individuals
Green sturgeon	The number of individuals supported by 525 acre-feet of water, estimated to be between 0-15 individuals

The anticipated take levels were based on the average number of each species collected during the May-July sampling effort during the 7-year monitoring period (1986-1992) extrapolated for the 15-year permit period.

3-2.10.2 Aquatic Filter Barrier (AFB)

Recently, a new physical barrier system has been undergoing several years of demonstration tests at the Lovett Generating Station on the Hudson River, New York. This system consists of a two-layer 0.6 mm thick filter fabric made of nonwoven fibers that creates a porous filtering media with an equivalent mesh opening of 0.212 mm (supplemental holes 0.5 mm in dia. were punched 6.4 mm on center to aid in overall porosity), suspended from a flotation boom, weighted bottom, an air burst cleaning system, and concrete anchoring blocks and attachment lines. The system was first deployed in 1994 as a pilot program, and has been expanded upon in each subsequent year with increasing success. In a one month study during initial 1997 deployment, the fabric barrier was found to have reduced entrainment by more than 80% (Ecological Analysts Inc. 1998) from a non-protected adjacent unit and during a longer subsequent study, entrainment was reduced by 76% (Applied Science Associates 1998) prior to a gap forming under one end, allowing unfiltered water to enter the plant. The Lovett Generating Station is sited in a similar estuarine environment with similar daily tidal elevation changes and velocities as at the Contra Costa Power Plant.

Based on the positive results from the Lovett demonstration study, and its similar environmental setting to the Contra Costa Power Plant, this technology, although undemonstrated at this level of flow, is promising and may be suitable for replacing the existing intake screens and resource management program to meet both the current NPDES BTA requirement to minimize striped bass losses as well as to replace the proposed VSD flow reduction to minimize the incidental take of the target aquatic species covered by this HCP. Consequently, SE proposes to conduct a test of the new AFB technology at the Contra Costa Power Plant.

A. Activities

Testing of the AFB will include two separate monitoring programs: 1) the primary monitoring program will be ichthyoplankton sampling to determine its effectiveness at excluding fish eggs and larvae from being entrained by the power plant, (Appendix H) and 2) a secondary program to monitor the physical integrity of the AFB (Appendix I). The AFB testing will be conducted for a maximum of three test periods, unless additional testing is requested by either the USFWS, NMFS, or CDFG. The first test period for the Phase I demonstration is proposed for February 1 through July 31, 2001 (the required VSD flow minimization period), however, in order to fully evaluate the AFB, VSD's will not be used during the test period. If any structural problems develop in the AFB during the term of any AFB evaluation that results in less than an 80% reduction in entrainment from collected samples for one week, VSD's will be used until such problems are remedied. If needed, additional tests will be conducted in subsequent years during the same time period. Also, a test of the physical integrity of the AFB may take place beyond the July 31 end date. No biological monitoring is proposed for any AFB evaluation beyond the end of the VSD flow reduction period (July 31).

Both Units 6 & 7 will be included in the study because their combined intakes prevents using one as a control and the other as a test case. It is anticipated that the required AFB length necessary to filter the required volume of water needed by the power plant will be approximately 1700 ft long and may extend up 350 ft offshore in basically a semi-circle configuration. One end will originate on the shore adjacent to the existing submerged intakes for Units 1-5 west of the intake for Units 6&7 and the other end of the AFB will be sited about 1100 ft to the east, just before where the cooling water discharge canal enters the San Joaquin River. The enclosed area is estimated to cover approximately 7.9 surface acres in front of the power plant with a volume of approximately 111 acre-feet of water. About 2.6 acres of this area consists of shallow water habitat less than 3 m below mean lower low water, and about half of which contains tules and cattails.

Evaluation of the effectiveness of the AFB will be accomplished by comparing simultaneously collected ichthyoplankton samples from both inside and outside of the barrier. Pumped samples will be collected from both the inside and outside at various areas along the .AFB as well as at the discharge as described in Section 3-2.10.1. Samples along the AFB will be collected either by placing sampling equipment on a barge adjacent to it or by extending sampling lines from shore based pumps. Sampling equipment and methodologies will be the same for each sampling location and will follow the protocols described in the previous section for striped bass entrainment sampling. Additionally, a limited effort using pushnets attached to small boats both inside and outside of the AFB during initial deployment is also planned. A biological monitoring and sampling study plan is included in Appendix H.

Evaluation of the physical integrity of the AFB will be accomplished by: (a) physical inspection by divers to ensure the integrity of the AFB with the bottom and the integrity of the panels, (b) observing that the boom is sufficiently suspending the AFB in the water column, (c) monitoring tension meters on selected tethering lines to determine system integrity, (d) monitoring differential head between the inside and outside of the AFB, (e) monitoring the overall appearance of the AFB by video camera linked to the power plant operations control room, (f) implementing a regular inspection and replacement program for tether lines and shackles, filter panels and other worn parts and (g) by observing any dramatic changes in efficacy in reducing entrainment The physical integrity study plan is presented in Appendix I.

B. Impacts

The AFB will create a temporary artificial embayment of approximately 7.9 surface acres with 2.6 acres of shallow water habitat less than 3 m deep. All of the fish and invertebrates within the enclosure will be subject to an increased level of potential entrainment and impingement on the power plant intake screens. Larger fish either not entrained or impinged will be subject to reduced forage species (i.e., small fish and invertebrates), and may increased mortality. To help minimize this impact, SE will conduct a fish rescue within the enclosure with an electrofishing boat. The effort expended and success criteria will be determined in consultation with USFWS, NMFS and CDFG. The placement of the AFB on the shoreline will also require the removal of approximately 0.04 acres of emergent vegetation (i.e., tules and cattails).

Sampling may result in the pursuit, capture, harassment, harm, and death of Delta smelt, longfin smelt, Sacrament splittail, chinook salmon, steelhead, and green sturgeon. Based on collecting 1,250 number of samples and approximately 30 acre-feet of water per test period (February 1-July 31), as described above, take of these species could reach between about 140-1,400 for Delta smelt, 0-1,400 for longfin smelt, 12-120 for Sacramento splittail, and 2-24 for chinook salmon each year that demonstration studies are conducted. These estimates were determined based on the general density levels of these species found during the 1978-1979 and entrainment sampling periods, and the adjusted current potential entrainment levels presented in Table 3-15. It was not possible to make estimates for either steelhead or green sturgeon because neither of these species were collected during the 1978-1979 studies.

MONTEZUMA HABITAT ENHANCEMENT SITE

3-3.0 HABITAT ENHANCEMENT ACTIVITIES AND IMPACTS

3-3.1 Habitat Enhancement Activities

Restoration and enhancement of the Montezuma Enhancement Site, designed to increase the quality and quantity of habitat for the sensitive plant, fish, and wildlife species addressed in this plan, will include the following measures (see Section 4 for more specific details of enhancement activities):

- Restoration of tidal flow by creating openings (about 100 ft in width) at the Sacramento River and Marshall Cut.

- Recontouring portions of the Montezuma site to create three dead-end sloughs of approximately 50 ft in width and 350 ft in length (sloughs will be contoured such that no "isolated pools" will be allowed to form under low tidal conditions).

- Recontouring the three constructed dead-end sloughs to increase the available tidal, intertidal, and upper tidal zones.

- Maintaining or slightly increasing salt marsh harvest mouse habitat.

These measures will be designed, implemented, and maintained in cooperation with USFWS, NMFS, and CDFG. During implementation, heavy equipment will be used to create dead-end sloughs and tidal openings, temporarily dewater all or portions of the Montezuma site, and construct temporary access roads, coffer dams, dikes, and laydown areas. Construction activities which will need to be conducted in Delta waters, e.g. levee removal, will be limited to late summer (August and September), when winter-run chinook salmon would not be expected to be impacted by these operations.

3-3.2 Habitat Enhancement Impacts

The use of heavy equipment to create the dead-end sloughs and tidal inlets will result in the temporary and permanent disturbance of sensitive species habitat. For aquatic species, the use of the existing aquatic habitat on the site is unknown and is limited by the size of the existing culvert structures and by the poor quality of the existing habitat. This HCP assumes that the existing aquatic habitat on site is essentially unavailable to the sensitive fish species targeted in the HCP. However, surveys for sensitive fish species will be conducted prior to implementing the habitat enhancement measures. If sensitive fish species are found during these pre-construction surveys, a more extended effort will be conducted to remove and relocate individuals to aquatic habitats adjacent to the site.

For terrestrial species, activities will occur during the late summer and fall, following the most active breeding and nesting periods for the sensitive species. -SE will conduct surveys for sensitive species prior to completing the Habitat Restoration Plan and prior to construction activities at the Montezuma Enhancement Site.

Surveys conducted between October 1977 and August 1978 at the site resulted in detection of salt marsh harvest mouse. However, no salt marsh harvest mice have been detected since that time, including a 1994 survey that included 75 trap nights. Salt marsh harvest mouse habitat has declined at the site over the past 20 years. In 1996, only 9.78 acres of suitable habitat remained at the 139-acre Montezuma site. The recently revised draft California Clapper Rail/Salt Marsh Harvest Mouse Recovery Plan no longer includes the Montezuma site as essential habitat area. It is unlikely that salt marsh harvest mice will be detected or impacted during construction activities at the Montezuma site.

If the survey results in the capture of one or more salt marsh harvest mice, those areas in which the mice are present will be avoided during the design and construction of the Montezuma Enhancement Site. Other take-avoidance measures, subject to USFWS and CDFG approval, will be instituted as needed if salt marsh harvest mice are detected during design and construction of the site.

The construction activities may result in the loss of suitable habitat of the following terrestrial species shown in Table 3-27.

Table 3-27. Anticipated Take of Habitat Acres during the Construction Activities at the Montezuma Enhancement Site

SPECIES	Anticipated take [1,2,3]
California black rail	The temporary or permanent loss of 57 acres of suitable habitat
Salt marsh harvest mouse	The temporary or permanent loss of 10 acres of suitable habitat

[1] Take is defined under the ESA as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct."
[2] Take is not expected to result in mortalities of individuals, and will consist of the # of observations, responses, or captures.
[3] Estimated numbers are from Foerster et al. (1990), and unpublished PG&E data.

Least terns and California clapper rails are not found at the Montezuma site, and are not included in the anticipated take table. The acres of available suitable habitat listed here are based on a vegetation survey conducted in 1994 and updated in 1997. Prior to enhancement activities, an additional survey will be conducted to establish baseline conditions at the site.

Section 4
MINIMIZATION, PROTECTION, AND ENHANCEMENT MEASURES

INTRODUCTION

Under Section 10(a)(2)(A) of the ESA and the ESA implementing regulations (50 CFR §§ 17.22(b)(1), 17.32(b)(1), and 222.22), an HCP submitted in support of an incidental take permit must detail "what steps the applicant will take to monitor, minimize, and mitigate such impacts [that will likely result from the taking of the species]." As stated in the USFWS and NMFS HCP Handbook, there are no specific rules for developing mitigation programs. According to the USFWS and NMFS HCP Handbook, mitigation generally takes the following forms: (1) avoiding the impact to the extent practicable, (2) minimizing the impact, (3) rectifying the impact, (4) reducing or eliminating the impact over time, and (5) compensating for the impact. Section 3 of this HCP presents the impacts likely to result from incidental take. This section addresses the minimization, protection, and enhancement measures proposed to mitigate for the impacts resulting from the proposed actions.

SE's Pittsburg and Contra Costa Power Plants' HCP is designed to contribute to the long-term recovery and survival of listed species in the Delta by incorporating minimization, protection, and enhancement measures into the HCP. Unlisted species will also benefit from these actions, which should help to decrease the need to list them in the future. These measures, based on federal Recovery Plan recommendations whenever possible, include new aquatic filtration methods, methods to minimize circulating water flow during important seasonal periods, seasonal limitations on maintenance activities in sensitive habitats, and the enhancement of habitat for aquatic and terrestrial species. The specific Recovery Plans and recommendations for the aquatic species in the HCP are described below. State-approved Recovery Plans were used if federal agency-approved plans were not available.

Portions of the minimization and habitat enhancement measures are based on the recommendations made in the **Sacramento-San Joaquin Delta Native Fishes Recovery Plan** (USFWS 1996), specifically Recovery Action 1 (Enhance/restore aquatic and wetland hab items 1-1122 and 1-1221). Post-habitat enhancement monitoring will also support Recovery Action 6 (Assess effects of Delta native fishes recovery management actions). The fish species covered by the HCP included in the Delta Native Fishes Recovery Plan are Delta smelt (listed as threatened by CDFG and USFWS); Sacramento splittail (listed as threatened by USFWS) and longfin smelt, which currently has no official status under the federal and state Endangered Species Acts. Spring-run (listed as threatened by CDFG) and fall/late fall-run chinook salmon and green sturgeon are also addressed in the Delta Native Fishes Recovery Plan.

Aquatic habitat enhancement supports Objective 5.2 (Preserve and restore tidal marsh habitat) of the **Recommendations for the Recovery of the Sacramento River Winter-run Chinook Salmon** (NMFS 1996). The winter-run chinook salmon is listed as endangered by NMFS and CDFG.

Aquatic habitat enhancement also supports the number one goal of the **Steelhead Restoration and Management Plan for California** (CDFG 1996) to increase natural production by restoring degraded habitat. The Central Valley ESU steelhead was listed as threatened by NMFS in March 1998.

These measures are intended to both reduce the take of the listed and unlisted species covered in this plan to the maximum practicable level during the term of the permit and to increase and enhance aquatic and terrestrial habitat (habitat for terrestrial species will be increased and enhanced to the extent consistent with the primary goal of aquatic habitat enhancement) in perpetuity. Specific minimization, protection, and enhancement measures are described in the following sections.

PITTSBURG POWER PLANT

4-1.0 POWER PLANT OPERATION MINIMIZATION MEASURES

The following operational modifications to the Pittsburg Power Plant will be implemented to minimize the potential impacts on sensitive aquatic species (Delta smelt, longfin smelt, winter-run chinook salmon, spring-run chinook salmon, fall/late fall-run chinook salmon, steelhead, Sacramento splittail, and green sturgeon). The minimization program will be evaluated by SE in conjunction with USFWS, NMFS, and CDFG after the first 5 years and after each subsequent 5-year period of the permit to assess the effectiveness of the program, as outlined in Section 6-2.0 of this HCP.

Phase I:

VSD Flow Minimizatic.. Measures

- <u>**Flow Reduction:**</u> The Pittsburg Power Plant will reduce the volume of circulating water flows through the Pittsburg Power Plant by operating the circulating water pumps in variable speed drive (VSD) mode between February 1 and July 31 of each year, when sensitive fish species are most susceptible to entrainment. A reduction in circulating water flows will also result in reducing impingement of fish greater than 38 mm long. VSD information is provided in Appendix E.

The target reduction threshold for the Pittsburg Power Plant will be 20% below design capacity of the circulating water pumps, based on a 7-day running average (18,250 acre-feet). This reduction in cooling water intake flow would be expected to result in a 20% reduction in entrainment and 20% reduction in impingement impacts on fish species from design capacity during the flow reduction period of February 1 to July 31.

Since flows will vary during the 7-day time period, the 20% estimate in reduction in impacts is an average reduction anticipated over this time period. On a daily basis, reductions in impacts can vary from 0 to 50% depending on which units are operated, load conditions, and duration of time when the circulating water pumps are operated in the VSD mode, compared to operation of the pumps at full design capacity.

The 20% flow reduction threshold for Pittsburg Power Plant was selected as an achievable target based on historical load demands and need to ensure the units are available for electrical system reliability.

- **Mitigation:** Load demands may require that the units be taken out of VSD mode. If the target reduction threshold is exceeded, mitigation compensation shall be provided, as outlined in Appendix F.

- **Maintenance and Protective Measures:** SE will maintain intake velocities as close as practicable to design levels by rotating and cleaning intake screens at a frequency of about four hour intervals, as shown in Table 3-5. Maintaining intake velocities to design specifications will also help to reduce potential impingement of fish greater than 38 mm long.

The minimization of impacts is based on seasonal reductions in circulating water flow to primarily reduce entrainment losses of larval and juvenile fish and secondarily on reducing impingement losses. During the 1978 and 1979 studies, entrainment was identified as having a much more significant impact than impingement on the local fish populations, primarily striped bass. Entrainment accounted for 99.8% of the combined number of fish estimated to be entrained and impinged on an annual basis, at design flow. Following those studies, a Resources Management Program (RMP) was developed at the power plants to reduce the loss of larval and juvenile striped bass during the entrainment period (May 1 through July 15). The results of the 1978-79 studies and subsequent monitoring efforts, as illustrated in Section 3 of this HCP, demonstrate that the focus of the minimization program for the listed target species in the HCP should also be on reducing the potential for entrainment during a selected time period. The Pittsburg Power Plant will operate the circulating water pumps in VSD mode under the HCP's Minimization Program to reduce impacts to sensitive fish screens. Use of VSDs will also reduce the number of fish impinged during this time period.

To reduce entrainment losses of larval and juvenile fish at large screened diversions, the **Sacramento-San Joaquin Delta Native Fishes Recovery Plan** (USFWS 1996) suggests either seasonal intake flow reduction for a predetermined period or flow reduction based on recent-time monitoring. The recent-time monitoring program is not practical at the Pittsburg Power Plant because energy resources must be planned in advance to ensure electrical system reliability and meeting electrical reliability load needs is an instantaneous requirement. Therefore, seasonal flow reduction was selected to minimize potential entrainment losses.

The period from February 1 to July 31 was selected to minimize the potential entrainment of larval and juvenile Delta smelt and longfin smelt. Reducing circulating water flow during this period will also protect juvenile Sacramento splittail, green sturgeon, and impingeable-sized outmigrating chinook salmon and steelhead smolts. Between 85% and 90% of all fish collected in the 1978-1979 entrainment studies were from the February 1 to July 31 period, and 83% of all impinged chinook salmon were also collected during this period. Depending on Delta water outflow, Delta smelt can spawn anywhere from Suisun Bay to the western Delta (Moyle 1976), typically between late February and May (Moyle et al. 1992). However, Wang (1991) reported Delta smelt spawning through late June or early July, with peak spawning occurring in late April and early May of 1989. After hatching, larvae are transported downstream by river currents until they reach the entrapment zone (null zone, mixing zone, etc.), where the lower bay salt water meets the fresh river water (Peterson et al. 1975 as cited in Moyle et al. 1992). The specific location of the entrapment zone varies seasonally and yearly as a function of river outflow. Consequently, the entrapment zone can occur either upstream or downstream of the power plant. Delta smelt larvae stay in the entrapment zone feeding on the abundant zooplankton (Orsi and Knutson 1979; Siegfried et al. 1979, and Stevens at al. 1985 as cited in Moyle et al. 1992), reaching 40-50 mm (FL) by early August (Erkkila et al. 1950; Radtke 1966 as cited in Moyle et al. 1992).

Adult and juvenile longfin smelt are euryhaline, living in salt and brackish water portions of the San Francisco Bay and Delta. Spawning takes place in fresh water between Rio Vista on the Sacramento River, Medford Island on the San Joaquin River and Montezuma Slough, in Suisun Marsh (Wang 1986). Spawning generally occurs between February and April (USFWS 1996); however, larvae have been found in plankton samples as early as November (R. Baxter, unpublished data as cited in USFWS 1994) and as late as June (Wang 1986, 1991).

The USFWS (1996) reports that most Sacramento splittail spawning occurs between February and April, similar to Delta smelt. Spawning can take place in dead end sloughs located in freshwater portions of the Delta and in the lower Sacramento and San Joaquin rivers upstream of the Delta. Spawning has also been recorded in Montezuma slough (Wang 1986). During some years the larvae stay in the shallow, weedy areas inshore where they were spawned and move to deeper water as they mature (Wang 1986).

Little is known about the life history and ecology of the green sturgeon (USFWS 1996). Green sturgeon are anadromous, and move from the ocean and bays into freshwater to spawn. In the Klamath River, peak spawning occurs from mid-April to mid-June (Emmett et al. 1991 as cited in USFWS 1996), and spawning times in the Sacramento River are probably similar. In the Klamath

River system, beach seine studies indicate that most fish leave the system between the ages of 1-4 at lengths of 30-70 cm, although most leave as yearlings (USFWS 1996).

Chinook salmon do not spawn in the Delta. In general, chinook salmon smolts are well developed when they enter the Delta and move through the estuary as they continue their outmigration to the Pacific Ocean (Sasaki 1966 as cited in Moyle 1976).

Steelhead are an anadromous species similar to chinook salmon in that the adults migrate past the power plants to upstream spawning areas, and downstream-migrating juveniles (smolts) move past the plants on their way to the ocean. Steelhead, however, spend 2 to 3 years in fresh water prior to moving out to the ocean. In general, these fish are large juveniles usually larger than 200 mm in length when they encounter the facilities, and can avoid the areas near the power plant's intake and discharge sites. Some juvenile steelhead are thought to use the lower portions (including shallow water areas) of the Sacramento and San Joaquin rivers as rearing habitat, so these individuals may be exposed to the power plants for an extended period.

Circulating water intake data can be used to estimate the entrainment of sensitive species resources during the flow reduction period. Table 4-1 provides examples of how the 1986-1992 Striped Bass Monitoring Program entrainment sampling data can be used to estimate the effectiveness of minimization measures. Although this monitoring program primarily targeted striped bass, it provided additional information on entrainment of Delta smelt, longfin smelt, Sacramento splittail, chinook salmon, steelhead, and green sturgeon. These estimates have not been adjusted to potential current levels because most, if not all, of these species already had experienced documented population declines for the period covered by this table. Also, these data were only collected from May through July and, therefore, cannot accurately reflect entrainment densities for the entire February-July time period.

Table 4-1. Estimated Entrainment of Individuals for the May-July Period at Pittsburg Power Plant at Design and 80% of Design Circulating Water Volumes Based on 1986-92 Sampling [1]

SPECIES	Design capacity	80% of design[2]
Delta smelt	12,924 ± 12,661	10,339 ± 10,128
Longfin smelt	58,160 ± 33,463	46,528 ± 26,770
Osmeridae[3]	407,122 ± 347,135	325,698 ± 277,708
Sacramento splittail	84,009 ± 36,833	67,207 ± 29,466
Winter-run chinook salmon[4]	0	0
Spring-run chinook salmon	0	0
Fall/late fall-run chinook salmon	0	0
Steelhead[4]	0	0
Green sturgeon[4]	0	0

[1] Estimates based on 7 years of entrainment densities (May-July), and includes 95% confidence intervals.
[2] The 80% circulating water flow threshold was selected to most effectively balance the need to minimize entrainment losses with the forecasted electricity demands over the life of the permit.
[3] Smelt not identified to species.
[4] No chinook salmon, steelhead, or green sturgeon were collected.

Table 4-2 provides estimated potential entrainment and effectiveness of flow minimization measures for February-July, and is based on a 12-month study conducted between March 1978 and March 1979 and also potential current estimated entrainment adjusted to reflect presently reduced population estimates. The use of adjustment factors for each of the listed species in this table was previously described in Section 3-2.4.1. A review of the original data indicated that 85-90% of the individuals of each species were collected between February and July, but because sampling efforts varied between months, it is not possible to simply reduce the yearly estimate to only February-July. Consequently, by using the entire 12-month estimate for this 6-month period, the estimated entrainment is actually overestimated by an unknown amount, but one that probably approximates 10-15%.

Table 4-2. Estimated Entrainment of Individuals for the February-July Period at the Pittsburg Power Plant at Design[1] and 80% of Design Flow of Circulating Water Volumes based on March 1978-March 1979 Sampling and Current Potential Estimated Entrainment at Design and 80% of Design Circulating Water Volumes

Species	Reduction Factor	1978-1979 Entrainment[2]		Potential Current Entrainment[3]	
		Design Flow	80% of Design	Design Flow	80% of Design
Delta smelt[4]	90%[5]	455,413 ± 184,516	364,330 ± 147,613	46,000	36,800
Longfin smelt[6]	90%[7]	190,229 ± 198,009	152,183 ± 158,407	19,000	15,200
Osmeridae[8]	90%[9]	64,784,071 ± 29,475,225	51,827,257 ± 23,580180	6,500,000	5,200,000
Sacramento splittail	62%[10]	155,289 ± 60,064	124,231 ± 48051	59,000	47,200
Winter-run chinook salmon	None	0	0	0	0
Spring-run chinook salmon	None	0	0	0	0
Fall/late fall-run chinook salmon	None[11]	23,598 ± 35,468	18,598 ± 28,374	23,598 ± 35,468	18,598 ± 28,374
Steelhead	None	0	0	0	0
Green sturgeon	None	0	0	0	0

1 Design flow represents 100% of all circulating water volume during an entire year.
2 Estimates based on 316(b) entrainment densities, and include 95% confidence intervals.
3 Estimates represent maximum potential based on design flows, actual flows are less.
4 Delta smelt collected ranged in length from 15 to 34 mm.
5 Federal Register Volume 58, No. 49/ Tuesday, March 16, 1993.
6 Longfin smelt collected ranged in length from 24 to 68 mm.
7 **Sacramento/San Joaquin Delta Native Fishes Recovery Plan**, USFWS, 1996.
8 Osmeridae collected ranged in length from 3 to 22 mm. Because most of the Osmeridae were collected in January and February, which is generally too early for Delta smelt, and coupled with the high number of longfin smelt collected relative to Delta smelt in the impingement studies, suggests that most of these larvae were probably longfin smelt.
9 Average of reductions for Delta smelt and longfin smelt.
10 Federal Register Volume 64, No. 25/Monday, February 8, 1999.
11 This run was reported in the Federal Register Volume 63, No. 45/Monday, March 9, 1998 to be at or near historical levels; consequently, no reduction factor is necessary.

Based on this table, use of the "adjusted" potential current entrainment estimate at 80% of design flow results in an estimated entrainment of 36,800 Delta smelt instead of the historical estimated value of 455,413. Similarly, longfin smelt and the Osmeridae classification also both see a decrease in their potential estimated entrainment levels from the historical 1978-1979 estimates of 190,229 and 64,784,071 to 15,200 and 5,200,000, respectively. Using the adjusted potential current entrainment at 80% of design flow also results in the estimated entrainment of approximately 47,200 splittail instead of the historical estimated number of 155,289. The number of fall/late fall-run chinook salmon is unaffected because its population was reported to be at or near historical levels in the Federal Register (Volume 63, No. 45/Monday, March 9, 1998).

Use of VSDs will also reduce impingement of fish both through the reduction in the absolute volume of circulating water through the power plant as well as through reduced velocities that they experience at the intake screens. Velocities through the intake screens are expected to potentially decrease by up to half of their design velocities (from 0.8 to about 0.6 fps for Units 1-4 and 0.4 fps for Units 5&6; see Table 3-4). Consequently, some portion of those fish which were previously impinged should now be able to avoid being impinged at the lower intake velocities. This reduction is variable, and is affected by many factors, including species, fish size, and actual velocity reduction realized. Estimated potential reductions in impingement losses based strictly on flow reductions for February through July are presented in Table 4-3, and are based on data collected in 1978-1979. Because impingement monitoring conducted in 1987-1990 was only conducted from July/August through February, data collected during the February-July minimization period was insufficient to provide meaningful analysis and is therefore not presented here.

As indicated in Table 4-3, a 20% flow reduction decreases the 1978-1979 estimated impingement of Delta smelt by up to 1,577, winter-run chinook salmon by up to 48, spring-run chinook salmon by up to 69, and fall/late fall-run chinook salmon by up to 114 individuals during the February-July minimization period. Comparing the column for "adjusted" 80% of design flow under the potential current impingement category to the "historical" column in this table results in a substantial reduction in the estimated impingement of Delta smelt from 7,886 to 632, longfin smelt from 16,471 to 1,320, splittail from 6,636 to 2,018, and winter-run chinook salmon from 238 to 14. Because there was no available adjustment factor to apply to spring-run chinook salmon, this estimate was left uncorrected. However, it is recognized that this population has experienced significant population declines over the past 20 plus years, and the impingement estimate provided here probably overestimates the current actual impingement level by a factor of 10. The number of fall/late fall-run chinook salmon is unaffected because its population was reported to be at or near historical levels in the Federal Register (Volume 63, No. 45/Monday, March 9, 1998).

Table 4-3. Estimated Impingement of Individuals for the February-July Period at the Pittsburg Power Plant at Design[1] and 80% of Design Flow of Circulating Water Volumes based on March 1978-March 1979 Sampling and Current Potential Estimated Impingement at Design and 80% of Design Circulating Water Volumes

Species	Reduction Factor	1978-1979 Impingement[2]		Potential Current Impingement[3]	
		Design Flow	80% of Design	Design Flow	80% of Design
Delta smelt	90%[4]	7,886 ± 3,614	6,309 ± 2,891	790	632
Longfin smelt	90%[5]	16,471± 6,669	13,177 ± 5,335	1,650	1,320
Osmeridae	None	0	0	0	0
Sacramento splittail	62%[6]	6,636 ± 3,493	5,309 ± 2,794	2,522	2,018
Winter-run chinook salmon	93%[7]	238 of 590 ± 96	190 of 472 ± 77	17 of 41	14 of 41
Spring-run chinook salmon	None[8]	343 of 590 ± 126	274 of 472 ± 101	343 of 590 ± 126	274 of 472 ± 101
Fall/late fall-run chinook salmon	None[9]	569 of 590 ± 232	455 of 472 ± 186	569 of 590 ± 232	455 of 472 ± 186
Steelhead	None	0	0	0	0
Green sturgeon	None	0	0	0	0

1 Design flow represents 100% of all circulating water volume during an entire year.
2 Estimates based on 316(b) entrainment densities, and include 95% confidence intervals.
3 Estimates represent maximum potential based on design flows; actual flows are less.
4 Federal Register Volume 58, No. 49/ Tuesday, March 16, 1993.
5 **Sacramento/San Joaquin Delta Native Fishes Recovery Plan**, USFWS, 1996.
6 Federal Register Volume 64, No. 25/Monday, February 8, 1999.
7 Reduction based on analysis presented in Section 3-2.9.2 of HCP; a reduction estimate of 99% between 1966 and 1991 was presented in **Recommendations for the Recovery of the Sacramento River Winter-Run Chinook Salmon**, March 9, 1996, by the Sacramento River Winter-Run Chinook Salmon Recovery Team.
8 No adjustment values for this species could be found in the literature, therefore; it was left uncorrected.
9 This run was reported in the Federal Register Volume 63, No. 45/Monday, March 9, 1998 to be at or near historic al levels; consequently, no reduction factor is necessary.

Phase II: The AFB will be implemented and substituted for the VSD Flow Minimization at the Pittsburg Power Plant, if AFB is demonstrated to be effective during Phase I at the Contra Costa Power Plant, to minimize the potential impacts on sensitive aquatic species (Delta smelt, longfin smelt, winter-run chinook salmon, spring-run chinook salmon, fall/late fall-run chinook salmon, steelhead, Sacramento splittail, and green sturgeon). An intensive biological monitoring p[illegible]am will be conducted to determined the effectiveness of the AFB at the plant. The program will be evaluated annually by SE in conjunction with USFWS, NMFS, and CDFG for up to three years, or SE may, in consultation with USFWS, NMFS, and CDFG, extend the program for a longer period of time. Following the demonstration period, the physical integrity of the AFB will be evaluated on an annual basis during the remaining term of the permit to assess its effectiveness as outlined in Section 6-2.1 of this HCP.

AFB Minimization

- SE will deploy the AFB around the Units 1-7 intakes between February 1 and July 31 of each year, at a minimum, when sensitive fish species are most susceptible to entrainment. At SE's discretion, the AFB may be deployed year-round. Based on results of studies conducted on a similar AFB at another power plant and the additional measures proposed for the Pittsburg Power Plant, it is expected that entrainment impacts will be reduced by approximately 80-99 percent. Deployment of the AFB will also result in reducing impingement of virtually all larvae, juveniles, and adult aquatic organisms due to expected flow through barrier velocities of about 0.02 fps.

- Because all of the plants cooling water will be filtered by passing through the AFB, it will not be necessary to implement VSD Flow Minimization with use of the VSD's to reduce circulating water pump usage, to have a 7-day running average flow, or to clean and rotate the existing intake screens to maintain through screen velocities.

Several measures will be implemented at the Pittsburg Power Plant and Contra Costa Power Plant that should make the AFB much more effective than at the Lovett Generating Station on the Hudson River. These measures include: (a) removing riprap and rocky debris from the shoreline, thereby improving AFB seal; (b) providing for separation between the discharge location and the AFB, there by causing less turbulent interference with the AFB; (c) ensuring that the entire bottom area is free of debris, thereby providing a proper seal of the AFB to the river bottom; (d) screen wastewater will not be discharged within the AFB area; (e) an enhanced physical maintenance and monitoring program will be implemented; and (f) overall improved AFB deployment layout should improve overall AFB performance.

The minimization of impacts is based on a seasonal (or year-round) deployment of the AFB to reduce entrainment and impingement losses of larvae and juvenile sensitive aquatic species. As was previously discussed in Phase I above, entrainment has been previously identified as the single largest impact of the operation of the Pittsburg Power Plant, accounting for up to 99.8% of the combined number of fish estimated to be entrained or impinged on an annual basis at full design flow. Additionally, the period of February 1 through July 31 was selected in consultation with USFWS, NMFS, and CDFG based on a review of results from the 1978-1979 316(b) studies (Ecological Analysts, Inc. 1981a) and the 1986-1992 Striped Bass Monitoring Program.

Based on Table 4-2, use of the AFB (with a reduction effectiveness of between 80 to 99%) has a potential to reduce the take of Delta smelt from the historic level of 455,413 to between about 4,554 to 91,100 annually, at full design flow. Furthermore, if the Potential Current Entrainment level column of this table is used, the potential entrainment level is further reduced to between about 460 to 9,200 annually, at full design flow. Because the power plant operates at less than full design flow on an annual basis, the actual entrainment would be less than described. The reduction in potential entrainment for the remaining species would be similar as for Delta smelt in this illustration.

4-2.0 HCP SPECIES PROTECTION MEASURES

4-2.1 General Maintenance and Repair Measures

The following terrestrial species and habitat protection measures, designed to minimize impacts on soft bird's-beak, California black rail, California clapper rail, California least tern, and salt marsh harvest mouse, will be adhered to by SE when conducting maintenance and repair activities within the Pittsburg Power Plant HCP Area. The maintenance and repair activities are described in Section 3-2.1.

- Fencing and controlled access will be maintained.
- Vehicles must be kept on access roads. A 15-mph speed limit will be observed on unpaved access roads.
- Firearms will be prohibited except for those used by security personnel.
- Feeding of wildlife is not allowed.
- Plant or wildlife species may not be collected for any reason.
- Littering is not allowed.
- All personnel working within the HCP Area will participate in an employee training program. SE will submit a draft employee training program to USFWS, NMFS, and CDFG for their review and approval within 30 days after receiving the federal incidental take permits; the agencies will then have 90 days to review and comment on the draft program, and the program will be implemented within 90 days after a final program is agreed to by all parties. The program will consist of a brief discussion of endangered species biology and the legal protections afforded these species, a discussion of the biology of the Sensitive Species addressed in the HCP, the habitat requirements of these species, their status under the Federal Endangered Species Act and the California Endangered Species Act, measures being taken for the protection of these species and their habitats under the HCP, and a review of the minimization and compensation measures. A factsheet conveying this information will also be distributed to all employees working in the HCP Area.
- If a population of soft bird's-beak must be cleared to comply with fire clearance criteria, the individual or population will be salvaged and transplanted to a suitable location within the HCP Area.
- Staging and storage areas for equipment and materials will be located on previously disturbed sites.

4-2.2 Seasonal and Habitat Impact Measures

In California clapper rail and California black rail habitat, no repair or maintenance activities will be scheduled in their reproductive season, February 1 through August 31.

In salt marsh harvest mouse habitat, no repair or maintenance activities will be scheduled at any time of year since the species' reproductive season could be at any time of year.

If repair and maintenance activities must occur during the reproductive period of California clapper rail, California black rail, or salt marsh harvest mouse habitat, surveys will be conducted to determine if the species are present. Surveys will be conducted using the most current USFWS/CDFG-approved protocol by a qualified biologist holding appropriate federal and California scientific collection permits.

If a clapper rail and black rail survey results in the vocal response of one or more individuals, no work shall be initiated within 700 feet of the detection(s) until September 1, or until the USFWS and CDFG are consulted and approval is received to initiate the work, except in emergencies (as described in Section 6.1-3).

If a salt marsh harvest mouse survey results in the capture of one or more individuals, no work shall be initiated until the USFWS and CDFG are consulted and approval is received to initiate the work, except in emergencies (as described in Section 6.1-3).

If SE conducts maintenance and repair activities within sensitive species habitats, SE will determine the amount of all surface habitat disturbance (acres), the type of impact (temporary or permanent and with or without sensitive species presence), and the habitat type impacted (pickleweed or coastal brackish marsh). This determination will occur within 10 working days of completion of the repair or maintenance activity. The site will be photo-documented and the compensation level of mitigation (Table 4-4) will be established. SE will conduct habitat restoration at the Pittsburg Power Plant site with the extent of restoration based on the compensation ratios presented in Table 4-4. All habitat restoration will be conducted at the Pittsburg Power Plant site or at another suitable site approved by USFWS and CDFG.

Surface habitat disturbance is where vegetation is removed or destroyed. Temporary impacts are those where no permanent (>12 months) surface facilities or appurtenances are installed.

Table 4-4. Compensation Ratios for Repair and Maintenance Activities at Pittsburg Power Plant

HABITAT TYPE	Temporary impact	Permanent impact (negative species survey results)	Permanent impact (positive species survey results)
Northern coastal salt marsh	1.1 : 1	2 : 1	3 : 1
Coastal brackish marsh	1.1 : 1	2 : 1	3 : 1

4-2.3 California Least Tern Measures

Over the last few years, the terns have been utilizing about 0.7 acre of the approximately 4.0 acres of potential nesting habitat on the site (potential habitat is considered to include the length of the Unit 7 cooling water canal center berm access road west of the predator control fence to the meteorological building).

SE will continue to manage vegetation in the least tern habitat. In addition, prior to nesting season (April 1 through August 31), SE will conduct vegetation management near known nest sites and will maintain nesting area fencing for predator control.

Repair and maintenance activities will be prohibited in areas utilized by the least tern as nesting habitat during their breeding season from April 1 through August 31.

If emergency repair and maintenance activities (as described in Section 6-1.2) must occur during that time period and there is not sufficient lead time to create alternative nesting habitat, surveys will be conducted to determine if least terns are nesting. Surveys will be conducted using USFWS/CDFG-approved protocol by a qualified biologist holding appropriate federal and California scientific collection permits.

The number of adults, nests and young will be determined during each visit. Measures will be taken to avoid directly impacting the nests. The nesting success of the birds will be monitored for the remainder of the nesting period to document any effect on reproductive success. A comparison with historical nesting success observations (1984-1999) will be completed to determine the need for remedial action.

Any reduction in nesting success will be mitigated by providing active predator management and/or additional appropriate nesting substrate on the canal access road in the following year, as directed by a qualified biologist or USFWS.

4-2.4 Sensitive Plant Species Measures

If ground-disturbing activities are planned for acres that have been identified as sensitive habitat for the soft bird's-beak in the most recent sensitive habitat mapping effort (conducted every 5 years), the area will be surveyed for presence of this plant species. All surveys will be conducted by a qualified botanist at the appropriate time and according to the protocol described by Nelson (1994) or any other certified protocol required by the USFWS. If any populations are identified during the surveys, the USFWS and the CDFG will be notified prior to commencing maintenance or repair activities and, if possible, these populations will be adequately fenced and protected in accordance with USFWS protocols during surface disturbing activities.

CONTRA COSTA POWER PLANT

4-3.0 POWER PLANT OPERATION MINIMIZATION MEASURES CONTRA COSTA

The minimization program will be evaluated after the first 5 years and after each subsequent 5-year period of the permit to assess the effectiveness of the program, as outlined in Section 6-2.0 of this HCP.

Phase I: As previously described in Section 3-2.10.2, the AFB will be implemented at the Contra Costa Power Plant as part of demonstration of a new technology to minimize entrainment and impingement at the plant as part of a phased approach. During Phase I, the AFB is planned to be deployed and fully operational by February 1, 2001 and will be kept in place through July 31. Implementation of the AFB is expected to minimize to the maximum practicable extent the potential impacts on sensitive aquatic species listed in the HCP (Delta smelt, longfin smelt, winter-run chinook salmon, spring-run chinook salmon, fall/fall-run chinook salmon, steelhead, Sacramento splittail, and green sturgeon). An intensive biological monitoring program will be conducted to determined the effectiveness of the AFB at the plant (See Appendix H for a full description). SE will evaluate this program annually in conjunction with USFWS, NMFS, and CDFG for up three years, or SE may, in consultation with these agencies, extend the program for a longer period of time. Following the demonstration period, the physical integrity of the AFB will be evaluated on an annual basis during the remaining term of the permit to assess its effectiveness as outlined in Section 6-2.1 of this HCP.

AFB Minimization

- SE will deploy the AFB around the Units 6&7 intakes between February 1 and July 31 of each year, at a minimum, when sensitive fish species are most susceptible to entrainment (See discussion in VSD Flow Minimization section below about seasonal abundance of sensitive aquatic species.). At SE's discretion, the AFB may be deployed year-round. Based on results of other studies conducted on a similar AFB at another power plant, and the additional measures proposed for the Contra Costa Power Plant, it is expected that entrainment impacts on all aquatic organisms will be reduced by approximately 80-99 percent. Deployment of the AFB will also result in reducing impingement of virtually all larvae, juveniles, and adult aquatic organisms due to expected flow through barrier velocities of about 0.02 fps.

- Because all of the plants cooling water will be filtered by passing through the AFB, it will not be necessary to implement VSD Flow Minimization with the use the VSD's to reduce circulating water pump usage, to have a 7-day running average flow, or to clean and rotate the existing intake screens to maintain through screen velocities.

Several measures will be implemented at the Pittsburg Power Plant and Contra Costa Power Plant that should make the AFB much more effective than at the Lovett Generating Station on the Hudson River. These measures include: (a) removing riprap and rocky debris from the shoreline, thereby improving AFB seal; (b) providing for separation between the discharge location and the AFB, there by causing less turbulent interference with the AFB; (c) ensuring that the entire bottom area is free of debris, thereby providing a proper seal of the AFB to the river bottom; (d) screen wastewater will not be discharged within the AFB area; (e) an enhanced physical maintenance and monitoring program will be implemented; and (f) overall improved AFB deployment layout should improve overall AFB performance.

The minimization of impacts is based on a seasonal (or year-round) deployment of the AFB to reduce entrainment and impingement losses of larvae, and juvenile sensitive aquatic species. As is discussed in the VSD Flow Minimization section below, entrainment has been previously identified as the single largest impact of the operation of the Contra Costa Power Plant, accounting for up to 99.8% of the combined number of fish estimated to be entrained or impinged on an annual basis at full design flow. Additionally, the period of February 1 through July 31 was selected in consultation with USFWS, NMFS, and CDFG based on a review of results from the 1978-1979 316(b) studies (Ecological Analysts, Inc. 1981b) and the 1986-1992 Striped Bass Monitoring Program.

Based on Table 4-6 (discussed in he VSD Section), use of the AFB (with a reduction effectiveness of between 80 to 99%) has a potential to reduce the take of Delta smelt from the historic level of 7,662 to between about 77 to 1,532 annually, at full design flow. Furthermore, if the Potential Current Entrainment level column of this table is used, the potential entrainment level is further reduced to between about 8 to 153 annually, at full design flow. Because the power plant operates at less than full design flow on an annual basis, the actual entrainment would be less than described. The reduction in potential entrainment for the remaining species would be similar as for Delta smelt in this illustration.

If the AFB is not demonstrated to be effective, then the VSD Flow Minimization described below will be implemented for the remaining term of the permit. Also, if for some reason problems develop during the term of any AFB evaluation that results in less than an 80% reduction in entrainment from collected samples for one week, VSD's will be used until collected samples once again achieve a minimum of an 80% reduction between inner and outer ichthyoplankton densities.

VSD Flow Minimization

The following operational modifications to the Contra Costa Power Plant will be implemented to minimize the potential impacts on sensitive aquatic species (Delta smelt, longfin smelt, winter-run chinook salmon, spring-run chinook salmon, fall/late fall-run chinook salmon, steelhead, green sturgeon, and Sacramento splittail).

- **Flow Reduction:** SE will reduce the volume of circulating water flows through the Contra Costa Power Plant by operating the circulating water pumps in variable speed drive (VSD) mode between February 1 and July 31 of each year, when sensitive species are most susceptible to entrainment. A reduction in circulating water flows will also result in reducing impingement of fish greater than 38 mm long. VSD information is provided in Appendix E.

  The target reduction threshold for the Contra Costa Power Plant would be 5% below design capacity of the circulating water pumps for Units 6 and 7 and a 100% reduction below design capacity for Units 1-5 (an overall reduction of 57% for Units 1-7), based on a 7-day running average (8,970 acre-feet). The proposed Unit 8 will reuse the discharged water from Unit 6 and 7. Should Unit 6 and 7 not be operating, a single unit 6 or 7 circulating water pump will be operated at 50% capacity to supply cooling tower makeup water. This reduction in intake flow would be expected to generally result in a 40% reduction in entrainment and about a 50% reduction in impingement impacts on fish species from design capacity during the flow reduction period of February 1 to July 31.

  On a daily basis, reductions in impacts can vary from 0 to 50% depending on load conditions and duration of time when the circulating water pumps are operated in the VSD mode, compared to operation of the pumps at full design capacity.

  The 5% flow reduction threshold for Contra Costa Units 6&7 was selected as an achievable target based on historical load demands and need to ensure the units are available for electrical system reliability.

  If Contra Costa Units 1-5 resume power generation operations requiring cooling water from the circulating water pumps, the HCP will be revised to reflect adjusted flow minimization thresholds and appropriate mitigation measures.

- **Mitigation:** Load demands may require that the units be taken out of VSD mode. If the target reduction threshold is exceeded, mitigation compensation shall be provided, as outlined in Appendix F.

- **Maintenance and Protective Measures:** SE will maintain intake velocities as close as practicable to design levels as shown in Table 3-14 by rotating and cleaning intake screens at a frequency of about four hour intervals. Maintaining intake velocities to design specifications will also help to reduce potential impingement of fish greater than 38 mm long.

The minimization of impacts is based on seasonal reductions in circulating water flow to primarily reduce entrainment losses of larval and juvenile fish and secondarily on reducing impingement losses. During the 1978 and 1979 studies, entrainment was identified as having a much more significant impact than impingement on the local fish populations, primarily striped bass. Entrainment accounted for 99.8% of the combined number of fish estimated to be entrained and impinged on an annual basis, at design flow. Following those studies, a Resources Management Program (RMP) was developed at the power plants to reduce the loss of larval and juvenile striped bass during the entrainment period (May 1 through July 15). The results of the 1978-79 studies and subsequent monitoring efforts, as illustrated in Section 3 of this HCP, demonstrate that the focus of the minimization program for the listed target species in the HCP should also be on reducing the potential for entrainment during a selected time period. As during the RMP, operating the circulating water pumps in variable speed drive (VSD) mode will be utilized under the HCP's VSD Flow Minimization Program to reduce intake flows. Use of VSDs will also result in reducing the number of fish impinged during this time period.

To reduce entrainment losses of larval and juvenile fish at large screened diversions, the **Sacramento-San Joaquin Delta Native Fishes Recovery Plan** (USFWS 1996) suggests either seasonal intake flow reduction for a predetermined period or flow reduction based on recent-time monitoring. The recent-time monitoring program is not practical at the Contra Costa Power Plant because energy resources must be planned in advance to ensure electrical system reliability and meeting electrical reliability load needs is an instantaneous requirement. Therefore, seasonal flow reduction was selected to minimize potential entrainment losses.

The period from February 1 to July 31 was selected to minimize the potential entrainment of larval and juvenile Delta smelt and longfin smelt. Reducing circulating water flow during this period will also protect juvenile Sacramento splittail, green sturgeon, and impingeable-sized outmigrating chinook salmon smolts, and steelhead. Between 85 and 90% of all fish collected in the 1978-1979 entrainment studies were from the February 1 to July 31 period, and 96% of all impinged chinook salmon were also collected during this time. Depending on Delta water outflow, Delta smelt can spawn anywhere from Suisun Bay to the western Delta (Moyle 1976), typically between late February and May (Moyle et al. 1992). However, Wang (1991) reported Delta smelt spawning through late June or early July, with peak spawning occurring in late April and early May of 1989. After hatching, larvae are transported downstream by river currents until they reach the entrapment zone (null zone, mixing zone, etc.), where the lower bay salt water meets the fresh river water (Peterson et al. 1975 as cited in Moyle et al. 1992). The specific location of the entrapment zone varies seasonally and yearly as a function of river outflow. Consequently, the entrapment zone can occur either upstream or downstream of the power plant. Delta smelt larvae stay in the entrapment zone feeding on the abundant zooplankton (Orsi and Knutson 1979; Siegfried et al. 1979, and Stevens at al. 1985 as cited in Moyle et al. 1992), reaching 40-50 mm (FL) by early August (Erkkila et al. 1950; Radtke 1966 as cited in Moyle et al. 1992).

Adult and juvenile longfin smelt are euryhaline, living in salt and brackish water portions of the San Francisco Bay and Delta. Spawning takes place in fresh water between Rio Vista on the Sacramento River, Medford island on the San Joaquin river and Montezuma Slough, in Suisun Marsh (Wang 1986). Spawning generally occurs between February and April (USFWS 1996); however, larvae have been found in plankton samples as early as November (R. Baxter, unpublished data as cited in USFWS 1996) and as late as June (Wang 1986, 1991).

The USFWS (1996) reports that most Sacramento splittail spawning occurs between February and April, similar to Delta smelt. Spawning can take place in dead end sloughs located in freshwater portions of the Delta and in the lower Sacramento and San Joaquin rivers upstream of the Delta. Spawning has also been recorded in Montezuma slough (Wang 1986). During some years the larvae stay in the shallow, weedy areas inshore where they were spawned and move to deeper water as they mature (Wang 1986).

Little is known about the life history and ecology of the green sturgeon (USFWS 1996). Green sturgeon are anadromous, and move from the ocean and bays into freshwater to spawn. In the Klamath River, peak spawning occurs from mid-April to mid-June (Emmett et al. 1991 as cited in USFWS 1994), and spawning times in the Sacramento River are probably similar. In the Klamath River system, beach seine studies indicate that most fish leave the system between the ages of 1-4 at lengths of 30-70 cm, although most leave as yearlings (USFWS 1996).

Chinook salmon do not spawn in the Delta. In general, chinook salmon smolts are well developed when they enter the Delta and move through the estuary as they continue their outmigration to the Pacific Ocean (Sasaki 1966 as cited in Moyle 1976).

Steelhead are an anadromous species similar to chinook salmon in that the adults migrate past the power plants to upstream spawning areas, and downstream-migrating juveniles (smolts) move past the plants on their way to the ocean. Steelhead, however, spend 1 to 3 years in fresh water prior to moving out to the ocean. In general, these fish are large juveniles usually larger than 200 mm in length when they encounter the facilities, and can avoid the areas near the power plant's intake and discharge sites. Some juvenile steelhead are thought to use the lower portions (including shallow water areas) of the Sacramento and San Joaquin rivers as rearing habitat, so these individuals may be exposed to the power plants for an extended period.

Circulating water intake data can be used to estimate the entrainment of sensitive species resources during the flow reduction period. Table 4-5 provides examples of how the 1986-1992 Striped Bass Monitoring Program entrainment sampling data can be used to estimate the effectiveness of flow minimization measures. This table provides a comparison of potential entrainment and reduction for operation of only Units 6 and 7 and of Units 1-7 for May-July. This represents a 57% reduction in cooling water volume and associated entrainment. Although this monitoring program primarily targeted striped bass, it provided additional information on entrainment of Delta smelt, longfin smelt, Sacramento splittail, chinook salmon, steelhead, and green sturgeon. These estimates have not been adjusted to potential current levels because most, if not all, of these species already had experienced documented population declines for the period covered by this table. Also these data were collected from May through July and, therefore, cannot accurately reflect entrainment densities during the entire February-July period.

Table 4-5. Estimated Entrainment of Individuals for the May-July Period (1986-1992) at the Contra Costa Power Plant for Units 6 and 7 Only at Design and 95% of Design Circulating Water Volumes and for Units 1-7 at Design Capacity for Circulating Water Volumes [1]

SPECIES	Units 6 and 7			Units 1-7	
	Design capacity	95% of design[2]	5% reduction	Design capacity	Overall reduction
Delta smelt	5,338 ± 5,230	5,071 ± 4,969	267 ± 261	11,863 ±11,621	6,792 ± 6,652
Longfin smelt	8,008 ± 6,403	7,608 ± 6,083	400 ± 320	17,795 ± 14,229	10,187 ± 8,146
Osmeridae[3]	170,829 ± 192,705	162,288 ± 183,070	8,541 ± 9,635	379,620 ± 428,232	217,332 ± 245,162
Sacramento splittail	10,677 ± 7,392	10,143 ± 7,022	534 ± 370	23,726 ± 16,426	13,583 ± 9,404
Winter-run chinook salmon[4]	0	0	0	0	0
Spring-run chinook salmon	0	0	0	0	0
Fall/late fall-run chinook salmon	0	0	0	0	0
Steelhead[4]	0	0	0	0	0
Green sturgeon[4]	0	0	0	0	0

[1] Estimates based on 7 years of entrainment sampling (May-July), 3,795 samples, and include 95% confidence interval.
[2] The 95% circulating water flow threshold was selected to most effectively balance the need to minimize entrainment losses with the forecasted electricity demands over the life of the permit.
[3] Smelt not identified to species.
[4] No chinook salmon, steelhead, or green sturgeon were collected.

Table 4-6 provides a comparison of potential entrainment and effectiveness of flow minimization measures for operation of only Units 6 and 7 and of Units 1-7 for the entire period of concern, February-July, and is based on a 12-month study conducted between April 1978 and April 1979 and also potential current estimated entrainment adjusted to reflect presently reduced population estimates. Unit 8 impacts are included within the Units 6 and 7 data. The use of adjustment factors for each of the listed species in this table was previously described in Section 3-2.4.1. A review of the original data indicated that 85-90% of the individuals of each species were collected between February and July, but because sampling efforts varied between months and because of the large extrapolations between sampled water volumes and design circulating water volumes, it is not possible to simply reduce the yearly estimate to only February-July. Consequently, by using the entire 12-month estimate for this 6-month period, the estimated entrainment is actually overestimated by an unknown amount, but one that probably approximates 10-15%.

Based on this table, the potential reduction in the historical 1978-1979 estimated entrainment for Delta smelt, Osmeridae, and Sacramento splittail would be 67%, 73%, and 44%, respectively, for operating Units 6 and 7 at 95% of design capacity compared with the estimated entrainment at design capacity for Units 1-7. Use of the "adjusted" potential current entrainment estimate at 95% of design flow results in the estimated entrainment of approximately 694 Delta smelt instead of the historical estimated value of 7,662 for Units 6 and 7 and 21,887 for Units 1-7. This is an eleven-fold reduction on a unit-for-unit basis and a thirty-fold reduction on a powerplant basis. Similarly, the Osmeridae classification also decreases by a factor of three from the historical potential estimated entrainment level of 132,604 to 47,880 for Units 6 and 7 on a unit-for-unit basis and by a factor of four from 189,659 on a powerplant basis. The number of fall/late fall-run chinook salmon is unaffected because its population was reported to be at or near historical levels in the Federal Register (Volume 63, No. 45). There is only a 5% potential reduction in fall/late fall-run chinook salmon entrainment because all the salmon originally sampled were from the Unit 6 and 7 intake.

Table 4-6. Estimated Entrainment of Individuals for the February-July Period at the Contra Costa Power Plant for Units 6 and 7 and Units 1-7 at Design[1] and 95% of Design Flow of Circulating Water Volumes Based on April 1978-April 1979 Sampling and Current Potential Estimated Entrainment at Design and 95% of Design Circulating Water Volumes

SPECIES	Reduction Factor	Units 6 and 7				Units 1-7			
		1978-1979 Entrainment[2]		Potential Current Entrainment[3]		1978-1979 Entrainment[2]		Potential Current Entrainment[3]	
		Design	95% of Design	Design	95% of Design	Design	95% of Design	Design	95% of Design
Delta smelt[4]	90%[5]	7,662 + 9,457	7,279 + 8,984	766	730	21,887 + 23,881	20,793 + 22,687	2,200	2090
Longfin smelt	None	0	0	0	0	0	0	0	0
Osmeridae[6]	90%[7]	5,936,097 + 1,317,392	5,639,292 + 1,251,522	594,000	564,300	20,543,854 + 5,601,594	19,516661 + 5,321514	2,000,00 0	1,900,000
Sacramento splittail	62%[8]	132,604 + 67,745	125,974 + 64,358	50,400	47,880	189,659 + 118,907	180,176 + 112,962	72,000	68,400
Winter-run chinook salmon	None	0	0	0	0	0	0	0	0
Spring-run chinook salmon	None	0	0	0	0	0	0	0	0
Fall/late fall-run chinook salmon	None[9]	10,318 + 18,820	9,802 + 17,879	10,318 + 18,820	9,802 + 17,879	10,318 + 18,820	9,802 + 17,879	10,318 + 18,820	9,802 + 17,879
Steelhead	None	0	0	0	0	0	0	0	0
Green sturgeon	None	0	0	0	0	0	0	0	0

[1] Design flow represents 100% of all circulating water volume during an entire year.
[2] Estimates based on 316(b) study entrainment densities, and include 95% confidence intervals.
[3] Estimates represent maximum potential based on design flows, actual flows are less.
[4] Delta smelt collected ranged in length from 26 to 47 mm.
[5] Federal Register Volume 58, No. 49/ Tuesday, March 16, 1993.
[6] Osmeridae collected ranged in length from 4 to 18 mm.
[7] Average of reductions for Delta smelt and longfin smelt (**Recovery Plan for the Sacramento/San Joaquin Delta Native Fishes,** USFWS, 1996).
[8] Federal Register Volume 64, No. 25/Monday, February 8, 1999.
[9] This run was reported in the Federal Register Volume 63, No. 45/Monday, March 9, 1998 to be at or near historical levels; consequently, no reduction factor is necessary.

Use of VSDs will also reduce impingement of fish both through the reduction in the absolute volume of circulating water through the power plant as well as through reduced velocities that they experience at the intake screens. Velocities through the intake screens are expected to potentially decrease to half of their design velocities (from 0.8 to 0.4 fps; see Table 3-14). Consequently, some portion of those fish which were previously impinged should now be able to avoid being impinged at the lower intake velocities. This reduction is variable, and is affected by many factors, including species, fish size, and actual velocity reduction realized. Estimated potential reductions in impingement losses based strictly on flow reductions for the February through July period are presented in Table 4-7, and is based on data collected in 1978-1979. Because impingement monitoring conducted in 1987-1990 was only conducted from July/August through February, data collected during the February-July minimization period was insufficient to provide meaningful analysis and is therefore not presented here.

The impingement reductions listed in Table 4-7 are a combination of the 5% circulating water flow reduction at Units 6 and 7 and of the 100% flow reduction from Units 1-5. Also, because Units 1-5 and Units 6 and 7 have separate intakes, the percentage reduction in impingement varies by species, and is not simply a straight mathematical reduction based on the overall 57% reduction in circulating water volume by combining design capacities of Units 1-5 and Units 6&7. The historical 1978-1979 impingement of Delta smelt may be reduced by 2,186, longfin smelt by 444, splittail by 4,826, winter-run chinook salmon by 40, spring-run chinook salmon by 100, fall/late fall-run chinook salmon by 64, and steelhead by 38 individuals during the February-July minimization period. Comparing the column for "adjusted" 95% of design flow under the potential current impingement category in this table to the "historical" column for Units 6 and 7 results in a substantial reduction in the estimated impingement of Delta smelt from 826 to 79, longfin smelt from 45 to 4, splittail from 5,277 to 500, and winter-run chinook salmon from 7 to >1. Because there was no available adjustment factor to apply to spring-run chinook salmon, this estimate was left uncorrected. However, this population has experienced significant population declines over the past 20 plus years and the impingement estimate provided here probably overestimates the current actual impingement level by at least a factor of 10. The number of fall/late fall-run chinook salmon is unaffected because its population was reported to be at or near historical levels in the Federal Register (Volume 63, No. 45/Monday, March 9, 1998).

Table 4-7. Estimated Impingement of Individuals for the February-July Period at the Contra Costa Power Plant for Units 6 and 7 and Units 1-7 at Design[1] and 95% of Design Flow of Circulating Water Volumes Based on April 1978 -April 1979 Sampling and Current Potential Estimated Impingement at Design and 95% of Design Circulating Water Volumes

Species	Reduction Factor	Units 6 and 7				Units 1-7			
		1978-1979 Impingement[2]		Potential Current Impingement		1978-1979 Impingement[2]		Potential Current Impingement	
		Design	95% of Design	Design	95% of Design	Design	95% of Design	Design	95% of Design
Delta smelt	90%[3]	826 ± 212	785 ± 201	83	79	2,971 ± 574	2,822 ± 545	297	282
Longfin smelt	90%[4]	45 ± 29	43 ± 28	5	4	487 ± 294	463 ± 279	49	47
Osmeridae	None	0	0	0	0	0	0	0	0
Sacramento splittail	62%[5]	5,277 ± 1,669	5,013 ± 1,586	530	500	9,839 ± 2,703	9,347 ± 2,568	3,740	3,00
Winter-run chinook salmon	93%[6]	7 of 298 ± 3	7 of 283 ± 3	>1 of 21	>1 of 21	47 of 694 ± 20	45 of 659 ± 19	3 of 46	3 of 46
Spring-run chinook salmon	None[7]	156 of 298 ± 69	148 of 283 ± 65	156 of 298 ± 69	148 of 283 ± 65	248 of 694 ± 164	236 of 659 ± 156	248 of 694 ± 164	236 of 659 + 156
Fall/late fall-run chinook salmon	None[8]	294 of 298 ± 129	279 of 283 ± 123	294 of 298 ± 129	279 of 283 ± 123	343 of 694 ± 141	326 of 659 ± 134	343 of 694 ± 141	326 of 659 ± 134
Steelhead	None	0	0	0	0	38 ± 39	36 ± 37	38 ± 39	36 ± 37
Green sturgeon	None	0	0	0	0	0	0	0	0

1. Design flow represents 100% of all circulating water volume during an entire year.
2. Estimates based on impingement densities from 316(b) studies, and include 95% confidence intervals.
3. Federal Register Volume 58, No. 49/ Tuesday, March 16, 1993.
4. **Sacramento/San Joaquin Delta Native Fishes Recovery Plan**, USFWS, 1996.
5. Federal Register Volume 64, No. 25/Monday, February 8, 1999.
6. Reduction based on analysis presented in Section 3-2.9.2 of HCP; a reduction estimate of 99% between 1966 and 1991 was presented in **Recommendations for the Recovery of the Sacramento River Winter-Run Chinook Salmon,** March 8, 1996, by Sacramento River Winter-Run Chinook Salmon Recovery Team.
7. No reduction values were available to correct historical to current levels.
8. This run was reported in the Federal Register Volume 63, No. 45/Monday, March 9, 1998 to be at or near historical levels; consequently, no reduction factor is necessary.

MONTEZUMA HABITAT ENHANCEMENT SITE

4-4.0 HABITAT ENHANCEMENT MEASURES

The primary goal of the restoration and enhancement measures is to increase the quality and quantity of shallow-water habitat for the target fish species. According to the **Sacramento-San Joaquin Delta Native Fishes Recovery Plan** (USFWS 1996), additional shallow-water habitat and vegetation zones can be expected to increase the availability of spawning areas and increase the general productivity of Delta native fishes. A secondary benefit to the enhancement project is that the quality and quantity of terrestrial habitat for sensitive plant and wildlife species will be enhanced to the extent possible and consistent with the primary goal of enhancing aquatic habitat. Enhancement activities will not result in the net loss of any sensitive terrestrial species habitat at the Montezuma enhancement site.

The following habitat restoration and enhancement measures will be implemented at the Montezuma Enhancement Site (Figure 4-1):

- SE will convey a Conservation Easement pertaining to the real property commonly known as the Montezuma Enhancement Site, County of Solano, consisting of approximately 139 acres of undeveloped land to a Conservation Entity for the conservation and protection of the sensitive species identified in this plan. The conservation easement will be conveyed to CDFG upon completion of habitat enhancement activities on site. Such easement will remain in effect in perpetuity.

- SE will restore tidal flow at the Montezuma Enhancement Site by creating openings (about 100 ft in width) at the Sacramento River and Marshall Cut.

- SE will recontour portions of the Montezuma Enhancement Site to create three dead-end sloughs of approximately 50 ft in width and 350 ft in length.

- SE will recontour the three constructed dead-end sloughs on the Montezuma Enhancement Site to increase the available tidal, intertidal, and upper tidal zones.

- SE will increase the quantity and enhance the quality of northern coastal salt marsh and coastal brackish marsh on the Montezuma Enhancement Site.

- The amount of funding to be contributed by SE to complete the restoration and enhancement of the Montezuma Enhancement Site is described in Section 7 of this HCP.

- SE and any successor or assign will maintain existing fencing to control access to the site.

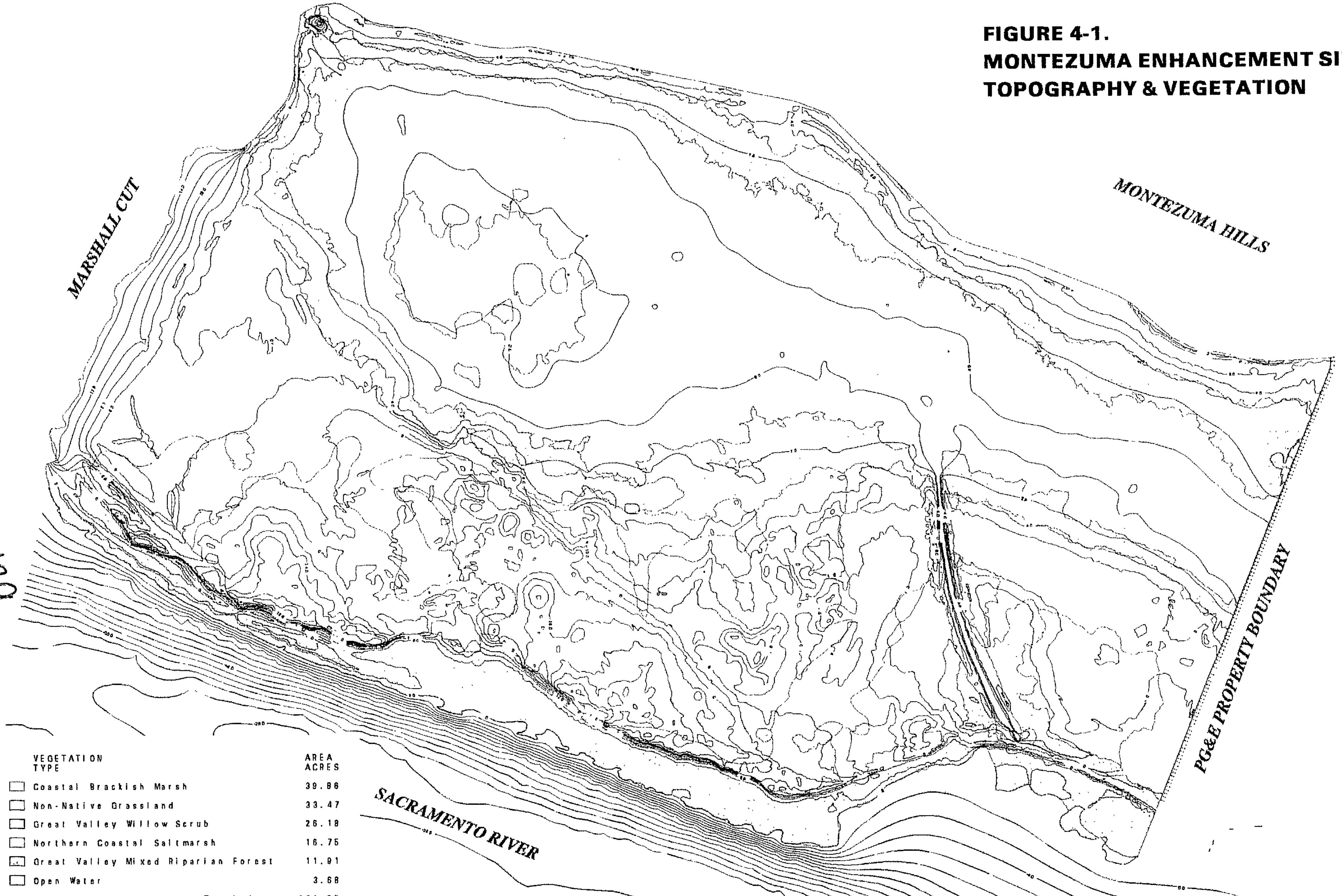
This basic plan has been evaluated and deemed feasible in a general overview by wetland restoration experts. The specific details of the reconstruction will be provided in the Montezuma Enhancement Site Plan as described in Section 4-4.4. A more detailed explanation of the evaluation process to date is contained in Section 4-4.3 of this section.

4-4.1 Montezuma Enhancement Site - Existing Condition

4-4.1.1 Site Description. SE proposes enhancement and restoration of its Montezuma property to facilitate the recovery of the species identified and addressed in this plan.

The Montezuma property is located in the Delta estuary in southeastern Solano County. It occupies about 139 acres north of the Sacramento River at its confluence with the San Joaquin River (Figure 3-1). The property is bordered to the west by Marshall Cut. The property lies about 17 miles southwest of Rio Vista and 12 miles southeast of Fairfield. Antioch and Pittsburg lie across the Sacramento River approximately 5 and 5.5 miles away, respectively. Two small towns are nearby: Collinsville lies about 1 mile to the west of the property, and Bird's Landing is about 4 miles to the north.

FIGURE 4-1.
MONTEZUMA ENHANCEMENT SITE
TOPOGRAPHY & VEGETATION



VEGETATION TYPE	AREA ACRES
Coastal Brackish Marsh	39.86
Non-Native Grassland	33.47
Great Valley Willow Scrub	26.18
Northern Coastal Saltmarsh	16.75
Great Valley Mixed Riparian Forest	11.91
Open Water	3.68
Total Acres	131.85

Vertical Datum: NAD29 Mean Sea Level Based on Benchmark BM3 1936
Horizontal Datum: California State Plane Coordinate System Zone 2 NAD 1927

Contour Interval: 2 Feet.

Elevation Data Sources:
Photogrammetric: American Aerial Surveys
Ground Survey: PG&E Building and Land Services
Bathymetric: PG&E TES Civil Engineering

Vegetation Data:
Vegetation polygon boundaries generated from aerial photos and GPS ground survey.

GIS Analysis and Graphics:
Robert Mulder
Technical & Ecological Services
Geographic Information Systems Lab
PG&E, San Ramon, CA
November, 1994

Elevations range from about -5 ft to over 200 ft in the nearby Montezuma Hills, which constitute the northern boundary of the property. Montezuma City was the name that Lansford Hastings gave to the area to the north of the Sacramento River, where it intersects the San Joaquin River, the area now known as Montezuma Hills. Hastings built an adobe house there in the 1840s and wrote the "Emigrant's Guide" to encourage settlers coming west to make their way through Sutter's Fort to the "contra costa."

This property, about 139 acres, was historically operated as a duck club, and is suitable for tidal wetland restoration and enhancement (Figure 4-1). Restoration and enhancement of the property is designed to restore spawning, nursery, and adult habitat for Delta smelt, longfin smelt, and Sacramento splittail and nursery habitat for outmigrating salmon and steelhead smolts. In addition, known habitat for the salt marsh harvest mouse, and potential habitat for California black rail and California clapper rail, will be maintained.

4-4.1.2 Existing Physical and Biological Conditions

A. Climate

The climate of the Montezuma Enhancement Site is strongly influenced by its location and topography. The Sacramento Valley, to the east and north, has hot, dry summers and cool winters; the area near the Pacific Ocean, to the south and west, has cool, humid summers and moderate winters. In summer, there is a steady marine wind that blows up the Carquinez Strait. Velocities of 15-25 knots are common late in the afternoon. The moderating influence of the marine air is reflected in the average daily temperatures (Table 4-8).

Table 4-8. Average Temperature and Precipitation at the Montezuma Enhancement Site

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average daily maximum (°F)	53	60	65	71	79	86	91	90	86	78	64	54
Average daily minimum (°F)	36	40	43	46	50	55	57	56	54	49	43	37
Average monthly precipitation (inches)	2.6	2.1	2.0	0.9	0.3	0.1	Trace	0.1	0.2	0.9	1.9	1.9

Average annual precipitation is about 25 inches, with about 95% of the total falling from October through April (Table 4-6). In winter the relative humidity averages about 90% at night and about 70% in the afternoon. When the humidity is near 100%, periods of fog occur and last several days to 2 weeks or more. In July the relative humidity averages about 75% early in the morning and drops to 55% in the afternoon. Annual evaporation averages about 44 inches, with about 70% of the water evaporation occurring from May to October.

B. Tides

Hydrologists split the San Francisco Bay/Delta estuary into two hydrologic systems, a northern reach running from the Delta through Suisun, San Pablo, and Central bays, where the pattern of water circulation and salinity is largely determined by flows from the Sacramento and San Joaquin rivers, and a southern reach consisting of the South Bay, which receives much less water from its tributaries. The Montezuma Enhancement Site is in the northern reach. The estuary is subject to the mixed semidiurnal tides typical of the West Coast; there are two unequal high tides and two unequal low tides in each roughly 25-hour period. In the northern reach, the tidal range decreases with distance from the ocean. At the Montezuma Enhancement Site, the tidal range is about 4 ft, based on data from the California Department of Water Resources tidal gauging station at Collinsville (data from January 7, 1986, through March 31, 1994, at 15-minute intervals).

Tidal flow within the site is restricted due to the levees surrounding the property and inlet/outlet structures of limited capacity. These structures are located in the southeast (24-inch-diameter gated culvert) and northwest (36-inch-diameter gated culvert) corners of the site. During the operation of the duck club, these inlet/outlet structures were used to flood portions of the site with freshwater from the Sacramento River, thus providing habitat for migratory waterfowl. The site was typically drained in summer to prevent extensive growth of tules (*Scirpus* ssp.) and cattails (*Typha* ssp.). Currently the inlet/outlet structures remain open year-round.

C. Soils

The Montezuma Enhancement Site is comprised almost exclusively of Valdez series silt loam and silty clay loam (Bates 1977). Both of these soil types are considered hydric soils (U.S. Army Corps of Engineers 1987). Areas of dredged sand also occur on the site. About 63% (83 acres) of the site consists of Valdez silt loam. In a representative profile, the surface layer of this soil is light brownish-gray, mottled light-gray and yellowish-brown silt loam. The subsoil is mottled light-gray, light yellowish-brown, and yellowish-brown silt loam about 20 inches thick. The substratum is mottled, light brownish-gray and pale-brown silt loam to a depth of more than 60 inches. This soil does not contain an excessive amount of salts. Permeability is moderately slow. Runoff is slow, and erosion is a slight hazard. The available water capacity is 9-11 inches and the effective rooting depth is 48 inches to more than 60 inches.

The remaining 49 acres of the site consists of Valdez silty clay loam. In a representative profile, the surface layer of this soil is light brownish-gray, mottled light-gray and yellowish-brown silty clay loam about 12 inches thick. The subsoil is mottled light-gray, light yellowish-brown, and yellowish-brown, stratified silty clay loam and very fine sandy loam about 20 inches thick. The substratum is mottled, light brownish-gray and pale-brown, stratified silty clay loam, silt loam, and very fine sandy loam and extends to a depth of more than 60 inches. This soil is strongly saline throughout the profile. Permeability is slow. Runoff is very slow, and erosion is a slight hazard. The water table is at a depth of 12-20 inches and limits the rooting depth of most plants.

The available water capacity is 6-8 inches, and the effective rooting depth is 60 inches or more where this soil is drained.

D. Plant Communities

Plant communities were delineated from black and white aerial photos (scale 1:4,200, flown August 16, 1994), and species associations and ground truthing were conducted onsite in August and September 1994 and in May 1997. Plant identification and nomenclature followed Hickman (1993). The vegetation classification system of Holland (1986), modified to suite the site, was used. Five plant communities were identified on the site (Figure 4-1 and Table 4-9). The results of previous floristic surveys of the site (Jones & Stokes, Inc., 1975, BioSystems Analysis, Inc., 1980) are included in Appendix C. Those surveys indicate that about 44% of the species identified on the Montezuma Enhancement Site were introduced species.

Table 4-9. Areas of the Various Plant Communities on the Montezuma Enhancement Site

COMMUNITY	Acres on site
Non-native grassland	33
Coastal brackish marsh	40
Northern coastal salt marsh	17
Great valley mixed riparian forest	12
Great valley willow scrub	26
Open water	11

Non-Native Grassland. This community is characterized by a dense to sparse cover of introduced annual grasses associated with numerous species of annual herbs. Dominant species within this community include soft chess (*Bromus hordeaceus*), ripgut grass (*B. diandrus*), wild oats (*Avena fatua*), Italian ryegrass (*Lolium multiflorum*), bermuda grass (*Cynadon dactylon*), star thistle (*Centaurea solstitialis*), heliotrope (*Heliotropium curassavicum*), white stem filaree (*Erodium moschatum*), sow thistle (*Sonchus asper*), curly dock (*Rumex crispus*), bristly ox tongue (*Picris echioides*), and prickly lettuce (*Lactuca serriola*).

Coastal Brackish Marsh. This community is dominated by perennial, emergent monocots to 6 ft tall. Cover is often complete and dense. Within the Montezuma Enhancement Site, this community is perennially inundated, with salinity varying considerably with season. Species characteristic of this community include tule (*Scirpus acutus* var. *occidentalis*), alkali bulrush (*S. robustus*), broad leaved cat tail (*Typha latifolia*), narrow leaved cat tail (*T. angustifolia*), giant reed (*Arundo donax*), and common reed (*Phragmites australis*).

Northern Coastal Salt Marsh. This community is highly productive, consisting primarily of salt-tolerant hydrophytes forming a fairly dense cover up to 3 ft tall. Within the Montezuma Enhancement Site, this community occurs between the Coastal Brackish Marsh and the upland communities. Currently, residual salts in the soil provide suitable conditions for the presence of halophytic vegetation although conditions for such vegetation seems to be declining. Dominant species include pickleweed (*Salicornia virginica*), alkali heath (*Frankenia salina*), salt grass (*Distichlis spicata*), spearscale (*Atriplex triangularis*), Australian saltbush (*A. semibaccata*), and rabbit's foot grass (*Polypogon monspeliensis*).

Great Valley Mixed Riparian Forest. This community is generally characterized by a fairly closed canopy of tall, dense, winter deciduous trees. The riparian forest present within the study area is only a remnant of the community that once existed here; it is degraded and lacks a closed canopy. Levee construction and shoreline erosion control measures have reduced the density and diversity of this community. Characteristic species within the Montezuma Enhancement Site include red willow (*Salix laevigata*), arroyo willow (*S. lasiolepis*), Fremont cottonwood (*Populus fremontii* ssp. *fremontii*), Himalayan blackberry (*Rubus discolor*), and marsh baccharis (*Baccharis douglasii*). This community occurs somewhat back from the river channel on relatively fine-textured alluvium.

Great Valley Willow Scrub. This community is characterized by open to dense thickets of sandbar willow (*Salix sessilifolia*). The thickets have little or no herbaceous component, while between thickets, a grassy understory is dominated by introduced species including soft chess (*Bromus hordeaceus*), ripgut grass (*B. diandrus*), fennel (*Foeniculum vulgare*), horehound (*Marrubium vulgare*), mulefat (*Baccharis salicifolia*), telegraph weed (*Heterotheca grandiflora*), coyote bush (*Baccharis pilularis*), and red-stemmed filaree (*Erodium cicutarium*). Stands of fennel, horehound and common reed occur within this community. Within the Montezuma Enhancement Site, this community occurs on relatively high, sandy soils.

Wetlands on the site will be delineated prior to submittal of the Habitat Enhancement Site Plan using the U.S. Army Corps of Engineers 1987 manual. According to this manual, except in certain situations (defined in the manual), evidence of a minimum of one positive wetland indicator from each diagnostic environmental parameter (hydrology, soil and vegetation) must be found to make a positive wetland determination. Approximately 73 acres of jurisdictional wetland associated plant communities occur on the Montezuma Enhancement Site.

E. Aquatic Species

No aquatic studies have been conducted at the Montezuma Enhancement Site. Aquatic species which may occur here are probably the same as described for Pittsburg Power Plant (Section 2-6.0).

F. Wildlife Species

Intensive wildlife species surveys were conducted at the Montezuma Enhancement Site from February 1973 through December 1974 (Jones & Stokes, Inc., 1975) and from October 1977 to August 1978 (BioSystems Analysis, Inc., 1980).

Reconnaissance-level wildlife surveys were conducted in October and November 1994. These surveys included small mammal trapping (75 trap nights), pit trapping (1944 trap hours), scent stations with Trailmaster™ infrared camera detection systems (480 trap hours), and incidental bird observations. Small mammal trapping was conducted from October 31 to November 1 using Sherman live traps. Pit trapping was conducted from October 25 to November 3 using 19-liter plastic buckets and 61-cm-high, 15-m-long aluminum flashing. Four Trailmaster™ infrared camera detection systems were set in the Coastal Brackish Marsh, Great Valley Willow Scrub, Great Valley Riparian Forest and Northern Coastal Salt Marsh communities. The systems were baited with cat food and fish emulsion. The results of the wildlife surveys conducted in 1994 as well as those from the previous studies (Jones & Stokes, Inc., 1975; BioSystems Analysis, Inc., 1980) are presented in Appendix D.

Surveys conducted between October 1977 and August 1978 resulted in detection of salt marsh harvest mouse. However, no salt marsh harvest mice have been detected since that time, including a 1994 survey that involved 75 trap nights. Salt marsh harvest mouse habitat has declined at the site in the past 20 years and only 9.78 acres of suitable habitat remained in 1996.

The area might support California black rail, although it is outside the current distribution for this species. The 1984 California Clapper Rail/Salt Marsh Harvest Mouse Recovery Plan identified the Montezuma Enhancement Site as a "Priority 3" essential habitat area to be managed as a diked marsh for salt marsh harvest mouse. However, the draft revised plan, under review in 1997, no longer includes this area as essential habitat.

G. Topographic/Geographic Information System (GIS) Mapping

The Natural Resource Conservation Service recommends a topographic survey to 1-ft contour elevations for most wetland sites to determine water depth, surface area, management possibilities, and quantities of construction materials (Soil Conservation Service 1992). Benchmarks were established in August 1994 and tied to locally recognized benchmarks with mean sea level datum. Contours (0.5 ft) were developed based on photogrammatical interpretation and conventional ground surveys conducted in August and September 1994. Aerial photography was at a scale of 1:4,200 flown on August 16, 1994. The ground survey was conducted in August and September 1994. The ground survey datum was NAD 29 msl based on BM3 - 1936. Figure 4-2 shows the topography of the Montezuma Enhancement

Site. A GIS database has been developed for the Montezuma Enhancement Site. Data layers include a 1-ft contour topographic map (Figure 4-1), vegetation, wetlands, soils, roads, and tidal zones.

4-4.2 Restoration and Enhancement Goals

The primary goals of the restoration and enhancement measures are to increase the quality and quantity of habitat for the fish species targeted in this HCP and, at the same time, to enhance the sensitive terrestrial communities to the extent possible and consistent with the primary goal. Enhancement activities will not result in the net loss of any sensitive terrestrial species habitat. Agency recovery plans for aquatic and terrestrial species covered by this HCP will be reviewed and incorporated as is consistent with the goals of the HCP. The final restoration plans will be reviewed and approved by USFWS, NMFS, and CDFG as described in Section 4-4.4. Species-specific restoration and enhancement objectives for all the sensitive species are as follows:

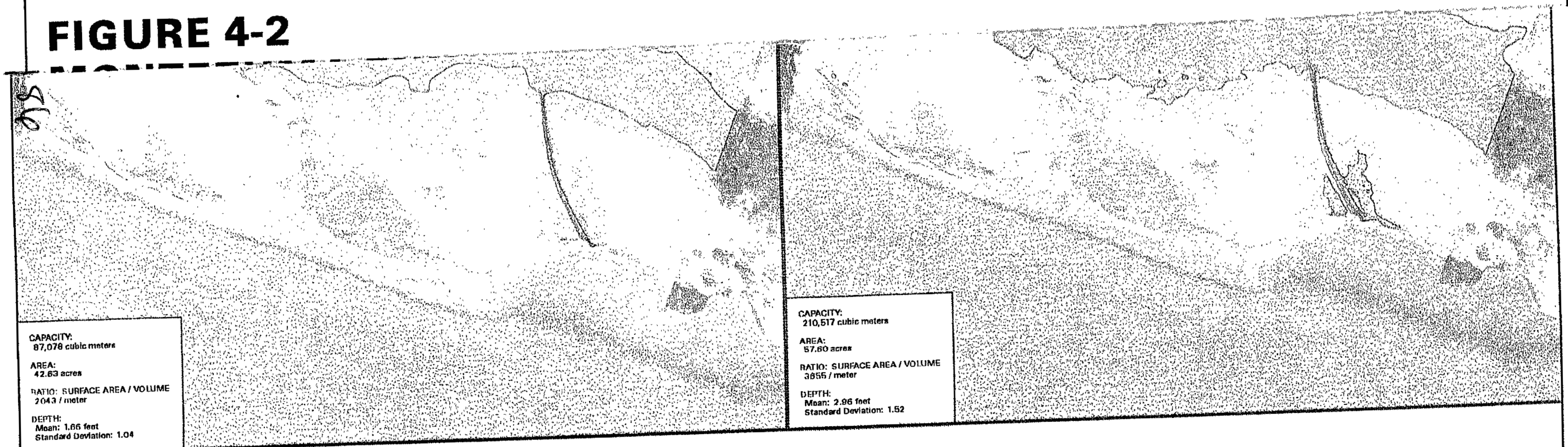
- **Delta smelt** - Create shallow channels and dead end sloughs with emergent or submergent vegetation. Provide tidal access to channels and dead-end sloughs.
- **Longfin smelt** - Expand shoreline vegetation, primarily emergent macrophytes, adjacent to the Sacramento River and in channels and dead-end sloughs.
- **Sacramento splittail** - Create shallow channels and dead-end sloughs with emergent or submergent vegetation. Provide tidal access to channels and dead-end sloughs.
- **Chinook salmon** - Create shallow channels and dead-end sloughs with emergent or submergent vegetation. Provide tidal access to channels and dead-end sloughs.
- **Steelhead** - Create shallow channels and dead-end sloughs with emergent or submergent vegetation. Provide tidal access to channels and dead-end sloughs.
- **Salt marsh harvest mouse** - Increase available northern coastal salt marsh habitat, especially dense pickleweed cover.
- **California black rail** - Increase high-elevation marsh within coastal brackish marsh habitat.

Enhancement and restoration at the Montezuma Enhancement Site will not directly benefit green sturgeon, California least tern, California clapper rail, and soft-bird's beak, the other species in this HCP. Impacts on these species will be minimized and mitigated at the Pittsburg Power Plant as described in Sections 4-2.3, 4-2.4, 4-1.0, and 4-3.0.

Table 4-10 lists the estimated amount of habitat available in 1997 at the Montezuma Enhancement Site for each species and the net gain in the amount of habitat anticipated through restoration and

FIGURE 4-2

86



Vertical Datum: NAD29 Mean Sea Level Based On Benchmark BM3 1938

Tide Data Source: Department of Water Resources - Collinsville Tide Gage

Elevation Data Sources:
Photogrammetric: American Aerial Surveys
Ground survey: PG&E Building and Land Services
Bathymetric: PG&E TES Civil Engineering

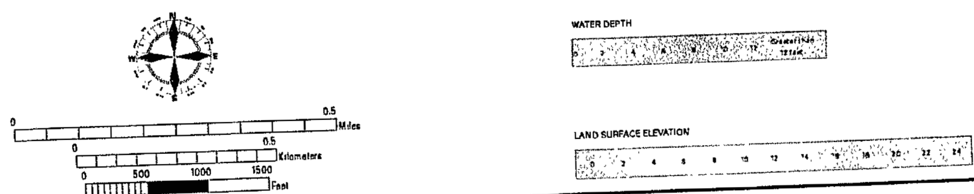
Vegetation Data:
Vegetation polygon boundaries were generated from aerial photos and GPS ground survey

Land Available for Restoration: 131.86 acres
Study Area Confined to: 121.46 acres
(Great Valley Mixed Riparian Forest excluded)

Prepared by:
Robert Mulder - GIS Analyst
PG&E TES GIS Lab, San Ramon, CA
September, 1996

Tidal Statistics:
Average Maximum Tide: 3.14 feet
Mean Tide: 1.13 feet
Average Minimum Tide: -1.05 feet

Study Area Elevation Statistics:
Maximum Elevation: 25.89 feet
Minimum Elevation: -9.07 feet
Mean Elevation: 4.37 feet
Standard Deviation: 5.05 feet



enhancement. The extent of aquatic and terrestrial habitat types for pre- and post-enhancement is shown in Table 4-11. Although there are 17 acres of northern coastal salt marsh on the site, only 10 acres are potential salt marsh harvest mouse habitat, based on areal extent, and height of pickleweed and other halophytes (Jones & Stokes Associates 1997).

Table 4-10. Estimated Existing and Anticipated Available Habitat for Target Species at the Montezuma Enhancement Site

SPECIES	Habitat type	Existing habitat (acres)	Restored habitat (acres)	Net change (acres)
Delta smelt	Flooded area at mean tide	0	56	+ 56
Longfin smelt	Flooded area at mean tide	0	56	+ 56
Sacramento splittail	Flooded area at mean tide	0	56	+ 56
Winter-run chinook salmon	Flooded area at mean tide	0	56	+ 56
Spring-run chinook salmon	Flooded area at mean tide	0	56	+ 56
Fall/late fall-run chinook salmon	Flooded area at mean tide	0	56	+ 56
Steelhead	Flooded area at mean tide	0	56	+ 56
Salt marsh harvest mouse	Northern coastal salt marsh	10	11	+ 1
California black rail	Northern coastal salt marsh and coastal brackish marsh	57	58	+ 1

Table 4-11. Extent of Existing and Post-Restoration Habitat at the Montezuma Enhancement Site

HABITAT	Existing extent (acres)	Post-restoration extent (acres)	Net change
Interior open water [1]	4	13	+9
Exterior open water [2]	7	7	0
Northern coastal salt marsh	17[3]	18	+1
Coastal brackish marsh	40	40	0
Upland	71	61	-10
Total	139	139	0

[1] Subject to restoration and enhancement.
[2] Includes Marshall Cut and small bay at southeast portion of property, which will not be increased or enhanced.
[3] Of the 17 acres of northern coastal salt marsh, only 10 acres were determined to be suitable habitat for salt marsh harvest mouse (Jones & Stokes Associates 1997).

The existing conditions at the Montezuma Enhancement Site are shown in Figure 4-2. The proposed restoration and enhancement is displayed in Figure 4-3. Restoration includes creating tidal inlets at the northwest and southeast portions of the site and recontouring. The inlets will be uncontrolled openings (about 100 ft across) that allow river access and tidal flow. In addition, three tidal sloughs (approximately 50 ft in width and 350 ft in length) will be created. Enhancement will include the re-establishment of pickleweed, saltgrass, and alkali heath. Impacts on existing wetlands and sensitive species habitats will be avoided wherever possible, although losses will be unavoidable in the course of achieving overall enhancement goals. Sensitive habitats that can be avoided will be fenced during construction and work will be monitored continuously by a biologist, disturbance from vehicular traffic will be minimized, and enhancement, restoration, and monitoring activities in sensitive habitats will be restricted to the period from September 1 through March 1.

Prior to habitat enhancement implementation, a two-phased analysis of the design of the habitat enhancement measures will be conducted. This analysis will include design assessment and identification of significant issues, and detailed analysis and design if required.

4-4.3 Design Assessment

To assess the potential design and maintenance issues associated with the construction of the tidally influenced sloughs at the Montezuma Enhancement Site, existing data from various sources will be used to identify any potential conditions which may prevent achievement and maintenance of the habitat criteria over the life of the permit. These data will include tidal elevations, water temperatures, suspended sediment concentrations, salinity and topographic data. The success criteria used to evaluate habitat condition as the area recovers are outlined in Section 5-3. Analysis will result in the incorporation of any minor design modifications necessary to enhance the likelihood of successful implementation as well as prevent potential maintenance problems. In addition, issues likely to require additional study will be identified.

4-4.3.1 Detailed Analysis and Design

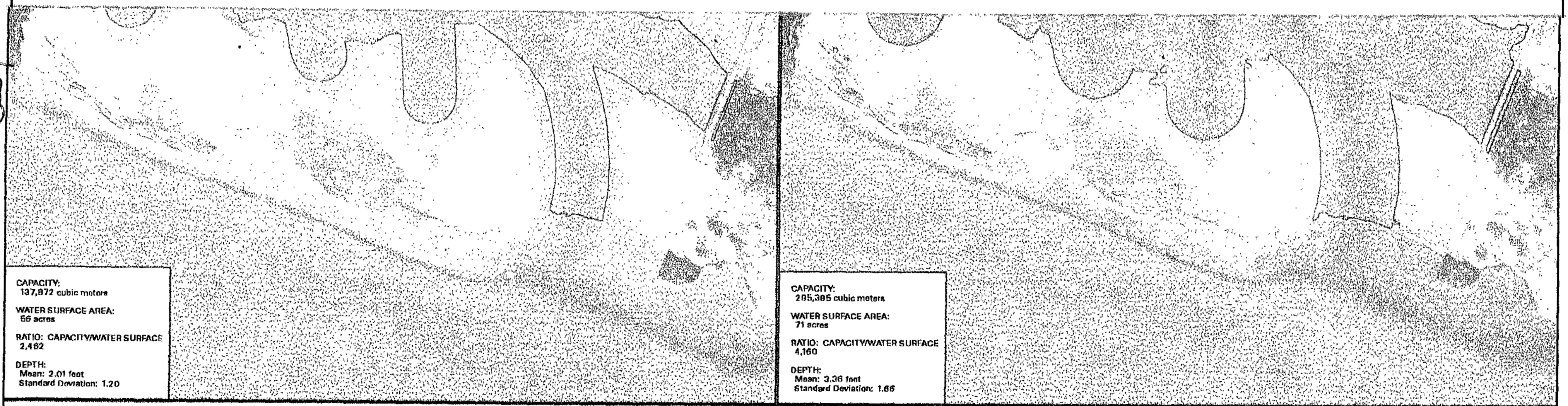
Should the first phase of the analysis indicate design problems (excessive sedimentation, lack of tidal circulation, elevated water temperature or salinity), the enhancement design will be modeled (hydrodynamic and transport model) to assess tidal circulation and flushing characteristics, hydroperiod on the marsh plain, and sedimentation.

Standard databases of geomorphic characteristics of San Francisco Bay wetlands and site specific data (tidal elevations, water temperatures, suspended sediment concentrations, salinity and topographic data) will be used.

The model will simulate the tidal flooding and drying of areas of the habitat enhancement; display results graphically; simulate the spatial variation of roughness due to vegetation, allow roughness to vary with depth, and simulate transitional and fully rough flow conditions; simulate cohesive sediment transport; and simulate water quality parameters. The results of the simulation model will facilitate design of the final physical characteristics of the enhancement plan.

Habitat criteria monitoring (see Section 5) will allow validation and calibration of the hydrodynamic transport model as well as measure success of the habitat enhancement plan. Habitat criteria measurement will identify when and if maintenance measures are likely to be required during the life of the permit. The hydrodynamic transport model will assist in

FIGURE 4-3



Vertical Datum: NAD29 Mean Sea Level Based On Benchmark BM 3 1936

Tide Data Source: Department of Water Resources - Collinsville Tide Gage

Elevation Data Sources:
Photogrammetric: American Aerial Surveys
Ground survey: PG&E Building and Land Services
Bathymetric: PG&E TES Civil Engineering

Vegetation Data:
Generated by extrapolation of existing conditions as applied to the proposed surface

Land Available for Restoration 131.86 acres
Study Area Confined to: 121.48 acres
(Great Valley Mixed Riparian Forest excluded)

Prepared by:
Robert Mulder - GIS Analyst
PG&E TES GIS Lab, San Ramon, CA
September, 1995

Tidal Statistics:

Average Maximum Tide: 3.14 feet

Mean Tide: 1.13 feet

Average Minimum Tide: -1.06 feet

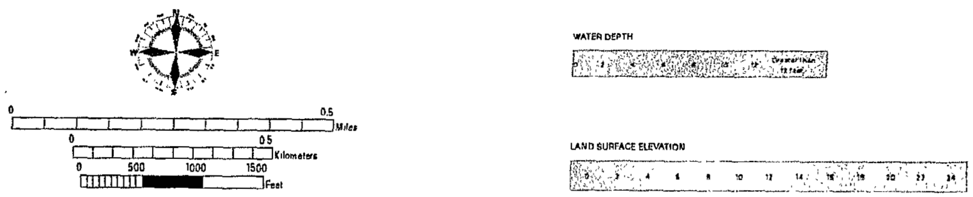
Study Area Elevation Statistics:

Maximum Elevation: 25.89 feet

Minimum Elevation: -9.07 feet

Mean Elevation: 3.48 feet

Standard Deviation: 5.30 feet



determining the most effective maintenance means to be employed to assure habitat enhancement effectiveness.

4-4.4 Habitat Enhancement Implementation

Specific standards, specifications and procedures (including construction drawings, material and construction requirements, safety and inspection plans, as well as site-specific procedures for controlling erosion, sedimentation, water and air pollution, and noise) will be established prior to implementation. Implementation encompasses all activities necessary to achieve the desired condition at the Montezuma Enhancement Site, including permitting and construction. SE will provide a Montezuma Enhancement Site Plan including all standards, specifications, and procedures to the USFWS, NMFS, and CDFG prior to implementation for review, comment, and approval. Unless otherwise agreed to by the Services, CDFG, and SE, SE will use all reasonable efforts to complete construction activities at the Montezuma Enhancement Site within 12 months, but not greater than 24 months, after the Services and CDFG provide SE with written approval of such habitat restoration plan and the relevant regulatory agencies issue to SE all permits needed to commence such activities.

Section 5
MONITORING

INTRODUCTION

As part of the requirements of Section 10(a)(2)(A) of the ESA and the ESA implementing regulations (50 CFR §§ 17.22(b)(1), 17.32(b)(1), and 222.22), an HCP submitted in an application for an incidental take permit must detail "what steps the applicant will take to monitor [the] impacts [that will likely result from the taking of the species]." The USFWS and NMFS HCP Handbook states that an HCP "should include periodic accountings of take, surveys to determine species status in project areas or mitigation habitats, and progress reports on fulfillment of mitigation requirements." According to the HCP Handbook, the monitoring plans "should establish target milestones, to the extent practicable, or requirements throughout the life of the HCP, and where appropriate adaptive management options."

This section describes the monitoring program proposed to perform periodic accountings of take, surveys to determine species status in project areas or mitigation habitats, and progress reports on fulfillment of mitigation requirements. The monitoring program will document and support implementation of the minimization and habitat enhancement measures over the life of the permit.

PITTSBURG POWER PLANT

5-1.0 MINIMIZATION MEASURES

5-1.1 Aquatic Resources

(Delta smelt; longfin smelt; Sacramento splittail; green sturgeon; winter-run, spring-run, and fall/late fall-run chinook salmon; and steelhead)

Due to the inherent differences between the aquatic filter barrier (AFB) and the variable speed discharge (VSD) minimization programs and the phased approach to implementing AFB at the power plants, each minimization program is discussed separately below.

5-1.1.1 VSD Minimization. Minimization of sensitive aquatic species impacts is based on seasonal reductions in circulating water flow to reduce entrainment and impingement losses of larval and juvenile fish. The reductions in flow will be achieved by committing to operate the circulating water pumps under variable speed drive (VSD) mode during the February 1 through July 31 period. During Phase I, VSD minimization will be used at the Pittsburg Power Plant. If the Phase I demonstration study of the AFB at the Contra Costa Power Plant is determined to be effective, AFB will be implemented at the Pittsburg Power Plant in Phase II (described in Section 5-1.1.2 below) and VSD minimization will be discontinued. If AFB is determined to be ineffective in Phase I at the Contra Costa Power Plant, AFB will not be deployed in Phase II at the Pittsburg Power Plant. Instead, VSD will be the minimization method used at the Pittsburg Power Plant for the remaining term of the permit.

The period from February through July was selected as the larvae and juveniles of the sensitive species are at a higher abundance during this time period. VSD operation will minimize the potential to entrain and impinge larval and juvenile Delta smelt and longfin smelt. Reducing circulating water flow during this period would also protect juvenile Sacramento splittail, green sturgeon, and outmigrating chinook salmon and steelhead smolts.

Circulating water intake volume will be monitored during the period February 1 through July 31. The water volume will be documented using hourly circulating water pump log speeds (in percent) and rated pump volume to calculate total circulating water intake of each unit on a daily basis. Daily volumes for all units will be totaled and reported as 7-day running averages annually at the end of each monitoring period.

The decision to focus the minimization program on circulating water volume rather than on the specific numbers of target fish species was based on the low abundances of those species in the system and the difficulty in conducting a monitoring program that accurately reflects the true abundance and, therefore, actual impacts. Within Chapter 3 of the Habitat Conservation Planning (HCP) Handbook (USFWS and NMFS 1996), the Services specify that "proposed incidental take levels can be expressed in the HCP in one of two ways: (1) in terms of the number of animals to be 'killed, harmed, or harassed' if those numbers are known or can be determined; or (2) in terms of habitat acres or other appropriate habitat units (e.g., acre-feet of water) to be affected generally or because of a specified activity, in cases where the specific number of individuals is unknown or indeterminable."

5-1.1.1.1 Threshold. To minimize the impact on sensitive aquatic resources, the circulating water pumps will be operated in VSD mode to reduce circulating water volume during the period February 1 through July 31, as explained in Appendix E. An 80% circulating water flow threshold target was selected to most effectively balance the need to minimize entrainment losses with the forecasted electricity demands over the life of the permit. The design capacity of all circulating water pumps at Pittsburg Power Plant is shown in Table 3-4 (Section 3). The circulating water volume threshold for Pittsburg Power Plant, based on 80% of design capacity, is 18,250 ac-ft/7-day period.

5-1.1.1.2 Remedy. If the 80% circulating water volume threshold based on a 7-day running average (18,250 ac-ft) is exceeded and if fish densities contemporaneously reach an agreed-upon fish threshold density, mitigation compensation as discussed in Appendix F will be deposited by SE into a special deposit account described in Section 7 of this HCP which will be established and dedicated to additional fish habitat restoration and enhancement activities. Appendix F specifies varying mitigation compensation amounts for Delta smelt and winter-run chinook salmon. An additional compensation amount will be provided to the fund for each subsequent exceedance of both threshold levels (flow and fish) over the same time period. If fish abundance indices are not determined over a particular time period for any reason and flow thresholds are exceeded over that same time period, the mitigation amount will be determined based on a similar water-year type, as agreed to by USFWS, NMFS, and CDFG. Funds will be dispersed with the review and approval of USFWS, NMFS, and CDFG.

Additionally, water flows will also have a volume threshold of 495,000 ac-ft during the February 1 to July 31 flow reduction period. This volume consists of a maximum volume of 474,000 ac-ft of circulating water for condenser cooling and 21,000 ac-ft of station service water and auxiliary pump flow. Water flows for the remainder of the year will be approximately 600,000 ac-ft for condenser cooling and 21,000 ac-ft for station service water and auxiliary pump flow for a combined total of 621,000 ac-ft. If the thresholds for total water flows are exceeded, SE-shall immediately notify USFWS, NMFS, and CDFG and negotiate appropriate permit amendments.

5-1.1.1.3 Reporting. Total daily circulating water volumes for each plant will be tabulated and presented as 7-day running averages for the period February 1 - July 31 each year. USFWS, NMFS, and CDFG will be notified if the circulating water thresholds are exceeded. SE will notify USFWS, NMFS, and CDFG of the first and last day of the exceedance period, within 3 working days of the beginning and end of the exceedance, including the daily circulating water flow for the exceedance period, or as otherwise directed by the agency.

A summary of actual and 7-day running average circulating water volumes, VSD operation information, and intake screen maintenance and operation will be provided annually. The mitigation compensation calculation will be tabulated for each 7-day running average and presented annually. This report will be furnished to the USFWS, NMFS, and CDFG annually on or before January 31 during the term of the permit.

5-1.1.2 AFB Minimization. If the AFB is demonstrated to be effective at substantially minimizing the impacts to sensitive aquatic species at the Contra Costa Power Plant during Phase I, it would then be implemented in lieu of VSD at the Pittsburg Power Plant during Phase II. Minimization of impacts to sensitive aquatic species is based on deployment of the AFB around the cooling water intake to the circulating water pumps, which will reduce both entrainment and impingement losses of larval and juvenile stages of sensitive aquatic fish species listed in the HCP. Initial implementation of the AFB at the Pittsburg Power Plant would occur in the first year following its effective demonstration at the Contra Costa Power Plant during Phase I, or earlier, if requested by USFWS, NMFS, and CDFG. If the AFB is not demonstrated effective either during

Phase I or Phase II studies, then the preferred method of minimization would be by VSD, as described above in Section 5-1.1.1. (VSD Minimization).

If implemented at the Pittsburg Power Plant, AFB will be deployed during the same time period as the VSD minimization program, February 1 to July 31 each year (as described above). At SE's discretion, the AFB may be left deployed year-round to minimize wear and reduce potential damage due to removing it from the water. The AFB is expected to have up to a 5-year effective life-span if left deployed on a year-round basis.

SE estimates that the successful implementation of the AFB could reduce entrainment and impingement impacts on sensitive aquatic organisms by 80-99 percent, depending on site specific characteristics and actual operating conditions. During the Phase II demonstration, the AFB will be subject to an intense biological and physical integrity monitoring study (described in Appendices H and I, respectively).

5-1.1.2.1 Threshold. To minimize the impacts on sensitive aquatic organisms, the AFB will be implemented at the Pittsburg Power Plant if this technology is practical and can achieve an 80 percent reduction in entrainable organisms for the period of February 1 - July 31 as determined by an intensive biological monitoring and sampling program (BMSP, see Appendix H) during the Phase II demonstration study. This program will use approved sampling protocols by the USFWS, NMFS, and CDFG to compare samples collected from both inside and outside of the AFB. Additionally, a physical monitoring and maintenance program (PMMP, see Appendix I) will also be conducted simultaneously with the BMSP. An 80% threshold target was selected , based on the results of a similar AFB that was deployed and evaluated on the Hudson River, New York.

Following a successful demonstration of the AFB at the Pittsburg Power Plant, it is anticipated that the BMSP will be either reduced in scope and effort, as determined in consultation with USFWS, NMFS, and CDFG, or possibly replaced entirely by a physical monitoring program, based on the PMMP (Appendix I).

5-1.1.2.2 Remedy. If the threshold target reduction of 80% of entrainable organisms (for the period of February 1 - July 31) is not achieved during Phase II after up to a three-year demonstration period, unless extended by mutual agreement between SE and the Services, then it will be discontinued and VSD minimization will be employed for the remainder of the permit period. If either during the Phase II demonstration or after a successful demonstration has been completed a structural failure of the AFB occurs that results in an opening of 10% of the overall area of the AFB that cannot be repaired in less than one week, then VSD minimization will be employed until the repair can be made. A sufficient number of backup panels and material needed to make general repairs of the AFB will be kept on site at the power plant at all times (see Appendix I).

5-1.1.2.3 Reporting. Annual reports of the results of the BMSP (Appendix H) and PMMP (Appendix I) will be submitted to USFWS, NMFS, and CDFG annually on or before January 31 during the demonstration study. Following a successful demonstration study, it is expected that a revised biological and physical monitoring program will be developed with the concurrence the USFWS, NMFS, and CDFG, which will be the basis for future reporting requirements. The Services and CDFG will be informed within three business days of any failure of the AFB which requires employing VSD minimization for more than two weeks.

5-1.2 Terrestrial Resources

Minimization of sensitive terrestrial species impacts is based on long-term protection of habitat for sensitive plant and animal species and seasonal restrictions on repair and maintenance activities within habitats that are suitable for threatened and endangered species, as described in Section 4-1.2.

5-1.2.1 Seasonal Limitations to Protect Animal Species. In California clapper rail and California black rail habitat, no repair or maintenance activities will be scheduled during their reproductive season, February 1 through August 31.

In salt marsh harvest mouse habitat, no repair or maintenance activities will be scheduled at any time of year since the species' reproductive season could be at any time of year.

If repair and maintenance activities must occur during the reproductive period (respectively) and in the habitat(s) of California clapper rail, California black rail, or salt marsh harvest mouse, surveys will be conducted to determine if the species are present. Surveys will be conducted using the most current USFWS/CDFG-approved protocol by a qualified biologist holding appropriate federal and California scientific collection permits.

If a clapper rail and black rail survey results in the vocal response of one or more individuals, no work shall be initiated within 700 feet of the detection(s) until September 1, or until the USFWS and CDFG are consulted and approval is received to initiate the work, except in emergencies (as described in Section 6.1-3).

If a salt marsh harvest mouse survey results in the capture of one or more individuals, no work shall be initiated until the USFWS and CDFG are consulted and approval is received to initiate the work, except in emergencies (as described in Section 6.1-3).

SE will continue to manage vegetation in the California least tern habitat. In addition, prior to nesting season (April 1 through August 31), SE will conduct vegetation management near known nest sites and will maintain nesting area fencing for predator control.

Repair and maintenance activities will be prohibited in areas utilized by the California least tern as nesting habitat during their breeding season from April 1 through August 31.

If emergency repair and maintenance activities (as described in Section 6-1.3) must occur during that time period and there is not sufficient lead time to create alternative nesting habitat, surveys will be conducted to determine if least terns are nesting. Surveys will be conducted using USFWS/CDFG-approved protocol by a qualified biologist holding appropriate federal and California scientific collection permits.

The number of adults, nests and young will be determined during each survey. Measures will be taken to avoid directly impacting the nests.

5-1.2.2 Plant Species. Suitable habitats (as determined from the sensitive habitat delineation repeated every five years as described in Section 5-1.2) will be surveyed for populations of soft bird's-beak prior to all ground disturbing activities within the Pittsburg Power Plant HCP Area. All surveys will be conducted by a qualified botanist at the appropriate time and according to the protocol described by Nelson (1994) or any other USFWS approved protocol. If any populations are identified during the surveys, the USFWS and the CDFG will be notified prior to commencing maintenance or repair activities, and these populations will be marked by the botanist by flagging or by the construction of temporary fencing to protect the sensitive populations during surface disturbing activities.

5-1.2.3 Threshold. Information on current levels of sensitive habitat and species presented in the HCP is based on studies conducted in the late 1970s (WESCO 1979). Baseline surveys of the sensitive habitats within the Pittsburg HCP boundary will be updated within one year from the date the permit is approved and then repeated on a 5-year basis. Sensitive habitats will be mapped using aerial photography and ground truthing.

Table 3-2 lists the anticipated maximum acreage impacts to sensitive terrestrial species habitat occurring in the Pittsburg HCP area. Based on SE previous levels of maintenance and repair activities, it is predicted that a maximum of 5 acres of combined temporary and permanent surface disturbance may occur over the 15-year term of the permit.

5-1.2.4 Remedy. If suitable habitat for California clapper rail, California black rail, or salt marsh harvest mouse is either temporarily or permanently impacted as a result of maintenance or repair activities, SE will provide remedy. SE will determine the amount of surface habitat disturbance, the type of impact (temporary or permanent and with or without the presence of species), and the habitat type impacted. This determination will be based on surveys conducted within 10 working days of completion of the repair or maintenance activity.

SE will conduct habitat restoration at the Pittsburg site with the extent of restoration based on the compensation ratios presented in Table 5-1. Surface habitat disturbance is where vegetation is removed or destroyed. Temporary impacts are those where no permanent surface facilities or appurtenances are installed.

Table 5-1. Compensation Ratios for Repair and Maintenance Activities at Pittsburg Power Plant

HABITAT TYPE	Temporary impact (positive species survey results)	Permanent impact (negative species survey results)	Permanent impact (positive species survey results)
Northern coastal salt marsh	1.1 : 1	2 : 1	3 : 1
Coastal brackish marsh	1.1 : 1	2 : 1	3 : 1

Following the repair or maintenance activity, the recovery of the disturbed area will be monitored. If the habitat does not recover within 12 months, supplemental plantings to encourage original coverage of the target vegetation types will be completed. If the habitat recovers within 24 months of the original disturbance, compensation will be awarded based on the ratios specified in Table 5-1 for temporary impact. If the habitat does not recover within 24 months following the disturbance, the temporary status of the area will be reclassified as a permanent loss of habitat to be compensated for under the ratios established for permanent impact in Table 5-1.

If emergency maintenance and repair work is conducted in the least tern habitat during its reproductive season, the nesting success of the California least terns will be monitored for the remainder of the nesting period to document any effect on reproductive success. A comparison with historical nesting success observations (1984-1996) will be completed to determine the need for remedial action. Any reduction in least tern nesting success resulting from maintenance and repair activities or loss of suitable nesting habitat will be mitigated by providing active predator management and/or additional appropriate nesting substrate on the canal access road in the following year, as directed by USFWS.

If the threshold for surface habitat acreage is exceeded, SE shall immediately notify USFWS and CDFG and negotiate appropriate permit amendments.

5-1.2.5 Reporting. Results of sensitive species and habitat surveys will be provided annually on or before January 31 during the term of the permit. A summary of impacts from maintenance and repair activities on sensitive species and habitat will be provided annually as stated above. A report of the results of measures taken to compensate for impacts to sensitive terrestrial species and habitat and status of recovery efforts will be provided annually.

If a scheduled repair or maintenance activity will result in exceedance of the threshold, the SFWS and CDFG will be consulted prior to the activity being conducted to determine the quantity, location and schedule for restoration and enhancement.

If an exceedance of habitat acreage impact results from an emergency repair or maintenance activity, the USFWS and CDFG will be notified within 5 working days. Coordination to determine the quantity, location, and schedule for restoration and enhancement will occur within one month of the emergency occurrence.

If SE, its employees, contractors or agents kills or injures an individual of a terrestrial species listed in Section 2.2, or finds any such animal dead, injured, or entrapped, SE shall immediately notify USFWS and CDFG. All reasonable efforts shall be made to allow any entrapped animals to escape. Any dead or injured animal shall be turned over to CDFG or USFWS, as directed, and a written report detailing the date, time, location and general description of the circumstances under which it was found must be submitted to CDFG and USFWS no later than three (3) business days following the incident.

CONTRA COSTA POWER PLANT

5-2.0 MINIMIZATION MEASURES

5-2.1 Aquatic Resources

(Delta smelt; longfin smelt; Sacramento splittail; green sturgeon; winter-run, spring-run, and fall/late fall-run chinook salmon; and steelhead)

Due to the inherent differences between the aquatic filter barrier (AFB) and the variable speed discharge (VSD) minimization programs and the phased approach to implementing AFB at the power plants, each minimization program is discussed separately below.

5-2.1.1 AFB Minimization. Deployment of AFB from February through July is predicated on the expectation that such technology will reduce impacts to sensitive aquatic species by 80 – 99 percent. If the AFB is demonstrated to be effective at substantially minimizing the impacts to sensitive aquatic species at the Contra Costa Power Plant during Phase I, it would then be continued at this power plant and implemented at the Pittsburg Power Plant during Phase II. Minimization of impacts to sensitive aquatic species is based on deployment of the AFB around the intakes to the Unit 6&7 circulating water pumps to reduce both entrainment and impingement losses of larval and juvenile sensitive aquatic fish species listed in the HCP. Initial implementation of the AFB at the Contra Costa Power Plant would occur by February 1, 2001. If the AFB is not demonstrated effective during the Phase I demonstration study, then the preferred method of minimization would be by VSD, as described below in Section 5-2.2.1. (VSD Minimization).

The AFB will be deployed from February 1 to July 31 each year, which is the period of highest abundance of sensitive species. At SE's discretion, the AFB may be left deployed year-round to minimize wear and reduce potential damage due to removing it from the water. The AFB is expected to have up to a 5-year effective life-span if left deployed on a year-round basis.

SE estimates that the successful implementation of the AFB could reduce entrainment and impingement impacts on sensitive aquatic organisms by 80-99 percent, depending on site specific characteristics and actual operating conditions. During the Phase I demonstration, a biological and physical integrity monitoring program (described in Appendices H and I, respectively) will be implemented to determine the efficacy of the AFB.

5-2.1.1.1 Threshold. To minimize the impacts on sensitive aquatic organisms, the AFB will be implemented at the Contra Costa Power Plant if this technology is practical and can achieve an 80 percent reduction in entrainable organisms for the period of February 1 - July 31 as determined by an intensive biological monitoring and sampling program (BMSP, see Appendix H) during the Phase I demonstration study. This program will use approved sampling protocols by the USFWS, NMFS, and CDFG to compare samples collected from both inside and outside of the AFB. Additionally, a physical monitoring and maintenance program (PMMP, see Appendix I) will also be conducted simultaneously with the BMSP. An 80% threshold target was selected , based on the results of a similar AFB that was deployed and evaluated on the Hudson River, New York.

Following a successful demonstration of the AFB at the Contra Costa Power Plant, it is anticipated that the BMSP will (in consultation with USFWS, NMFS, and CDFG) be reduced in scope and effort or possibly replaced entirely by a physical monitoring program, based on the PMMP (Appendix I).

5-2.1.1.2 Remedy. If the threshold target reduction of 80% of entrainable organisms (for the period of February 1 - July 31) is not achieved during Phase I after up to a three-year demonstration period, unless extended by mutual agreement between SE and the Services, then it will be discontinued and VSD minimization will be employed for the remainder of the permit period. If either during the Phase I demonstration study or after a successful demonstration has been completed a structural failure of the AFB occurs that results in an opening of 10%of the overall area of the AFB that cannot be repaired in less than one week, then VSD minimization will be employed until the repair can be made. A sufficient number of backup panels and specialized material needed to make general repairs of the AFB will be kept on site at the power plant at all times.

5-2.1.1.3 Reporting. Annual reports of the results of the BMSP (Appendix H) and PMMP (Appendix I) will be submitted to USFWS, NMFS, and CDFG annually on or before January 31 during the demonstration study. Following a successful demonstration study, it is expected that a revised biological and physical monitoring program will be developed with the concurrence the USFWS, NMFS, and CDFG, which will be the basis for all future reporting requirements. The Services and CDFG will be informed within three business days of any failure of the AFB which requires employing VSD minimization for more than two weeks.

5-2.1.2 VSD Minimization. Minimization of impacts on sensitive aquatic species is based on seasonal reductions in circulating water flow to reduce entrainment and impingement losses of larval and juvenile fish. The reductions in flow will be achieved by committing to operate the circulating water pumps under variable speed drive (VSD) mode during the February 1 through July 31 period. During the Phase I demonstration at the Contra Costa Power Plant AFB minimization will be employed, see Section 5-2.1.2 below. If AFB is determined to be ineffective during Phase I, then VSD will be the minimization method used at the Contra Costa Power Plant for the remaining term of the permit.

The period from February through July was selected as the larvae and juveniles of the sensitive species are at a higher abundance during this time period. VSD operation will minimize the potential to entrain and impinge larval and juvenile Delta smelt and longfin smelt. Reducing water flow during this period will also protect juvenile Sacramento splittail, green sturgeon, and outmigrating chinook salmon and steelhead smolts.

Circulating water intake volume will be monitored from February 1 through July 31. The water volume will be documented using hourly circulating water pump log speeds (in percent) and rated pump volume to calculate total circulating water intake of each unit on a daily basis. Daily volumes for all units will be totaled and reported as 7-day running averages annually at the end of each monitoring period.

The decision to focus the minimization program on circulating water volume rather than on specific numbers of target fish species was based on the low abundances of those species in the system and the difficulty in conducting a monitoring program that accurately reflects the true abundances and, therefore, actual impacts. Within Chapter 3 of the Habitat Conservation Planning (HCP) Handbook (USFWS and NMFS 1996), the Services specify that "proposed incidental take levels can be expressed in the HCP in one of two ways: (1) in terms of the number of animals to be 'killed, harmed, or harassed' if those numbers are known or can be determined; or (2) in terms of habitat acres or other appropriate habitat units (e.g., acre-feet of water) to be affected generally or because of a specified activity, in cases where the specific number of individuals is unknown or indeterminable."

5-2.1.2.1 Threshold. To minimize the impact on sensitive aquatic resources, the circulating water pumps will be operated in VSD mode to reduce circulating water volume during the period February 1 through July 31. A 95% circulating water flow threshold target, based on Units 6&7 only, was selected to most effectively balance the need to minimize entrainment losses with the forecasted electricity demands over the life of the permit. The design capacity of all circulating water pumps at Contra Costa Power Plant is shown in Table 3-13 (Section 3). Since Units 1-5 at Contra Costa are no longer operated for power generation, an adjusted threshold target was developed for Contra Costa Units 6&7 only. The circulating water volume threshold for Contra Costa Power Plant, based on 95% of design capacity for Units 6&7 only, is 8,970 ac-ft/7-day period. If some or all of Units 1-5 are brought back into service during the term of the permit, the permit will be amended accordingly with USFWS, NMFS, and CDFG concurrence before the units are brought back into service.

5-2.1.2.2 Remedy. If the 95% circulating water volume threshold based on a 7-day running average (8,970 ac-ft) is exceeded and if fish densities attain an agreed upon fish threshold density concurrently, mitigation compensation, as discussed in Appendix F, will be deposited by SE into a special deposit account (described in Section 7 of this HCP) that will be established and dedicated to additional fish habitat restoration and enhancement activities. Appendix F specifies varying mitigation compensation amounts for Delta smelt and winter-run chinook salmon. An additional compensation amount will be provided to the fund for each subsequent exceedance of the threshold levels (flow and fish) over the same time period. If fish abundance indices are not determined over a particular time period for any reason and flow thresholds are exceeded over that same time period, the mitigation amount will be determined based on a similar water-year type, as agreed to by USFWS, NMFS, and CDFG. Funds will be dispersed with the review and approval of USFWS, NMFS, and CDFG.

Additionally, water flows will also have a volume threshold of 241,000 ac-ft during the February 1 to July 31 flow reduction period. This volume consists of a maximum volume of 233,000 ac-ft of circulating water for condenser cooling and 8,000 ac-ft of station service water and auxiliary pump flow. Water flows for the remainder of the year will be approximately 248,000 ac-ft for condenser cooling and 8,000 ac-ft for station service water and auxiliary pump flow for a combined total of 256,000 ac-ft. If the thresholds for total water flows are exceeded, SE shall immediately notify USFWS, NMFS, and CDFG and negotiate appropriate permit amendments.

5-2.1.2.3 Reporting. Total daily circulating water volumes for each plant will be tabulated and presented as 7-day running averages for the period February 1 - July 31 each year. USFWS and NMFS will be notified if the circulating water thresholds are exceeded. SE will notify USFWS and NMFS of the first and last day of the exceedance period, within 3 working days of the beginning and end of the exceedance, including the daily circulating water flow for the exceedance period, or as otherwise directed by the agency.

A summary of actual and 7-day running average circulating water volumes, VSD operation information, and intake screen maintenance and operation will be provided annually. The mitigation compensation calculation will be tabulated for each 7-day running average and presented annually. This report will be furnished to the USFWS, NMFS, and CDFG annually on or before January 31 during the term of the permit.

MONTEZUMA HABITAT ENHANCEMENT SITE

5-3.0 HABITAT ENHANCEMENT MEASURES

5-3.1 Aquatic Habitat Monitoring

The aquatic habitat enhancement measures support the **Sacramento-San Joaquin Delta Native Fishes Recovery Plan** (USFWS 1996), **Recommendations for the Recovery of the Sacramento River Winter-run Chinook Salmon** (NMFS 1996), and the **Steelhead Restoration and Management Plan for California** (CDFG 1996) by creating shallow-water habitat for sensitive aquatic species. The goal of habitat enhancement at the Montezuma site is to provide approximately 56 acres of suitable spawning, nursery, and adult habitat for sensitive aquatic species.

Documenting the success of habitat restoration and enhancement measures at the Montezuma site will include measuring and monitoring physical and biological variables.

Monitoring will include collecting and analyzing baseline physical and biological data 1 year prior to implementation of habitat enhancement measures and at specified intervals (1, 2, 3, 5, 7, 10, and 15 years) after implementation to evaluate the successful achievement and maintenance of the specified parameters at the habitat restoration site as described in Section 5-3.2.

5-3.1.1 Topography. The Natural Resource Conservation Service recommends a topographic survey to 1-ft contour elevations for most wetland restoration sites to determine water depth, surface area, management possibilities, and quantities of construction materials (Soil Conser ··on Service 1992).

A baseline topographic survey of the Montezuma site was completed in 1994 (Figure 4-1). Contours (1-ft) were developed based on photogrammatical interpretation and conventional ground surveys conducted in August and September 1994. Aerial photography was flown on August 16, 1994 at a scale of 1:4,200. The ground survey was conducted in August and September 1994. The ground survey datum was NAD 29 msl based on BM3 - 1936.

mouths. Young-of-the-year and age-l splittail were common in beach seine sampling by the CDFG in 1993 along the Sacramento River between Rio Vista and Chipps Island (USFWS 1996). Furthermore, in the CDFG Bay Study samples, splittail are more common from stations less than 6.7 m (21 ft) deep. Thus, juvenile splittail may be concentrated in the shallow peripheries of the Sacramento River, and they may be more abundant there than indicated by sampling done to date (USFWS 1996).

Daniels and Moyle (1983) found that year-class success in splittail was positively correlated with Delta outflow, and Caywood (1974) found that a successful year-class was associated with winter runoff sufficiently high to flood the peripheral areas of the Delta. These observations were confirmed by the analysis of the state (CDFG 1992b). Meng (1993) found a strong negative relationship between amount of water diverted from the Delta and abundance of young splittail, noting that the effect of diversions seemed to be particularly strong in dry years.

Occurrence at the Pittsburg and Contra Costa Power Plants: All life stages of Sacramento splittail occur in the vicinity of the Contra Costa and Pittsburg Power Plants. Their abundance is dependent on the type of water year (i.e., the amount of freshwater outflow). In wet years, when freshwater conditions prevail for longer periods of time, larger numbers of splittail, particularly juveniles and larvae, are expected in the vicinity of the plants. Thus, during wet years, juvenile splittail are more susceptible to impingement at the intake screens, and larval spittail are more susceptible to entrainment in the circulating water system.

Green Sturgeon (*Acipenser medirostris*)

Status: The green sturgeon has no official state or Federal status.

Life History: The ecology and life history of green sturgeon have received little study. The adults are more marine than white sturgeon, spending limited time in estuaries or freshwater. In the Klamath River system, green sturgeon migrate up-river between late February and late July. The spawning period is March–July, with a peak from mid-April to mid-June (Emmett et al. 1991). Spawning times in the Sacramento River are probably similar. Spawning occurs in deep, fast water. In the Klamath River, a pool known as "The Sturgeon Hole" (1.5 km upstream from Orleans, Humboldt County) apparently is a major spawning site, because leaping and other behavior indicative of courtship and spawning are often observed there during spring and early summer (Moyle 1976). Female green sturgeon produce 60,000–140,000 eggs (Moyle 1976), each being about 3.8 mm in diameter. Based on their presumed similarity to white sturgeon, green sturgeon eggs probably hatch about 196 hours (at 12.7°C) after spawning. Juveniles migrate out to sea before 2 years of age, primarily during the summer-fall period (Emmett et al. 1991). Length-frequency analyses of sturgeon caught in the Klamath estuary in beach seines indicate that most green sturgeon leave the system at lengths of 30–70 cm. Individuals tagged by the CDFG in San Pablo Bay (part of the San Francisco Bay system) have been recaptured off Santa Cruz, in Winchester Bay on the southern Oregon coast, at the mouth of the Columbia River, and in Gray's Harbor, Washington (Chadwick 1959, Miller 1972).

Green sturgeon grow approximately 7 cm per year until they reach maturity at 130–140 cm, about age 15–20 (USFWS 1982). Growth slows after they reach maturity, and maximum size in the Klamath River in recent years has been around 230 cm (USFWS 1982). The largest fish have been aged at 40 years, but this is probably an underestimate (USFWS 1996). The largest green sturgeon are typically females, and virtually all fish over 200 cm are female (USFWS 1982).

Juveniles and adults are benthic feeders and may also take small fish. Juveniles in the Sacramento–San Joaquin Delta feed on opossum shrimp (*Neomysis mercedis*) and amphipods (*Corophium* sp.) (Radtke 1966). Adult sturgeon caught in Washington feed mainly on sand lances (*Ammodytes hexapterus*) and callianassid shrimp (F. Foley, UCD, unpublished data).

Abundance: In California, green sturgeon have been collected in small numbers in marine waters from the Mexican border to the Oregon border. They have been noted in a number of rivers, but spawning populations are known only in the Sacramento and Klamath rivers.

The San Francisco Bay system, comprising San Francisco Bay, San Pablo Bay, Suisun Bay, and the Delta, is home to the southernmost reproducing population of green sturgeon. Green sturgeon were originally described from San Francisco (Ayres 1854). White sturgeon are the most abundant sturgeon in this system, and green sturgeon have always been comparatively uncommon (Ayres 1854, Jordan and Gilbert 1883). Intermittent studies by the CDFG between 1954 and 1991 have measured and identified 15,901 sturgeon of both species. Based on these data, a green sturgeon to white sturgeon ratio of 1:9 was derived for fish less than 101 cm FL and 1:76 for fish greater than 101 cm FL (USFWS 1996). If it is assumed that green sturgeon and white sturgeon are equally vulnerable to capture by various gear and that the CDFG population estimates of white sturgeon (11,000–128,000, depending on the year) are accurate (Kohlhorst et al. 1991), then the number of green sturgeon longer than 102 cm has ranged from 200 to 1,800 fish in the estuary (USFWS 1996). These numbers should be regarded as very rough estimates because the above assumptions are uncertain.

Numbers of juvenile green sturgeon are more variable than numbers of adults since reproduction is presumably episodic (Kohlhorst et al. 1991). One indication of this is the numbers of green sturgeon (mostly juveniles) salvaged at the pumps of the SWP and CVP in the south Delta. Between 1979 and 1991, 6,341 fish identified as green sturgeon were captured at the two facilities combined; 32,708 white sturgeon were identified in the same period. Annual numbers ranged from 45 (1991) to 1,476 (1983). Other high salvage years were 1982 (1,093) and 1985 (1,377). However, these data are not very reliable because of poor quality control on both counts and species identification (USFWS 1996). In addition, juvenile sturgeon are probably more vulnerable to entrainment at low or intermediate outflows.

Indirect evidence indicates that green sturgeon spawn mainly in the Sacramento River. They have been reported in the mainstem Sacramento River as far north as Red Bluff, Tehama County (river km 383) (Fry 1979). Young green sturgeon have been taken near Hamilton City, Glenn County (Fry 1979). Additionally, four young green sturgeon were collected at the Red Bluff Diversion Dam in late October 1991 (USFWS 1996). River guides have taken adult green sturgeon at the Anderson Hole, about 6 km above the Hamilton Bridge (USFWS 1996). A dead adult green sturgeon was found on April 18, 1991, approximately 5 km south of Dairyville, Tehama County (USFWS 1996). Live adult green sturgeon have been observed by USFWS crews surveying winter-run chinook salmon (*Oncorhynchus tshawytscha*) in the 16-km reach of river below Red Bluff Diversion Dam in 1991 and 1992 (USFWS 1996). In 1991, 20 large sturgeon were sighted in this area between April 3 and May 21. Pat Foley of the University of California, Davis reported recent photographs of green sturgeon taken by sportfishers in the Feather River, a tributary of the Sacramento. It is possible that some spawning may occur in the San Joaquin River, because young green sturgeon have been taken at Santa Clara Shoal, Brannan

Island State Recreational Area, Sacramento County (Radtke 1966), and a single specimen from Old River is in the California Academy of Science collection (USFWS 1996).

Distribution: In North America, the green sturgeon ranges in the ocean from the Bering Sea to Ensenada, Mexico, a range that includes the entire coast of California. They have been found in rivers from British Columbia south to the Sacramento River in California. There is no evidence of green sturgeon spawning in Canada or Alaska, although small numbers have been caught in the Fraser and Skeena rivers, British Columbia (Houston 1988). Green sturgeon are particularly abundant in the Columbia River estuary, and individuals have been observed 225 km inland in the Columbia River (Wydoski and Whitney 1979); they are currently found almost exclusively in the lower 60 km and do not occur upstream of Bonneville Dam (Oregon Department of Fish and Wildlife 1991). There is no evidence of spawning in the Columbia River or other rivers in Washington. In Oregon, juvenile green sturgeon have been found in several of the coastal rivers (Emmett et al. 1991), but spawning has only been confirmed in the Rogue River (A. Smith, minutes to USFWS meeting on green sturgeon, Arcata, California, May 3, 1990; P. Foley, UCD, unpublished notes). In California, green sturgeon spawning has been confirmed in recent years only in the Sacramento and Klamath rivers, although spawning probably once occurred in the Eel River as well (Moyle et al. 1993).

Habitat Requirements: Habitat requirements of green sturgeon are not well known, but spawning and larval ecology probably are similar to that of white sturgeon. Comparatively large egg size, thin chorionic layer on the egg, and other characteristics indicate that green sturgeon probably require colder, cleaner water for spawning than white sturgeon (USFWS 1996). In the Sacramento River, adult sturgeon are in the river, presumably spawning, when temperatures range between 8 and 14°C. Preferred spawning substrate is large cobble, but can range from clean sand to bedrock. Eggs are broadcast-spawned and externally fertilized in relatively high water velocities and probably at depths >3 m (Emmett et al. 1991). The importance of water quality is uncertain, but silt is known to prevent eggs from adhering to each other.

Occurrence at the Pittsburg and Contra Costa Power Plants: Green sturgeon occur in the vicinity of the Contra Costa and Pittsburg Power Plants as adults during upriver spawning migrations in the spring, and as juvenile fish either moving downriver to the marine system or utilizing the western Delta area as rearing habitat. Adults and juvenile fish are large enough to easily avoid the power plant intakes.

Soft Bird's-Beak (*Cordylanthus mollis* ssp. *mollis*)

Status: This plant is proposed for listing as endangered by the USFWS, is listed as rare by the CDFG, and is considered rare, threatened, or endangered throughout its range by the California Native Plant Society (Skinner and Pavlik 1994).

Description: The soft bird's-beak is a member of the Scrophulariaceae (figwort or snapdragon) family. This annual plant is 20-40 cm tall and well branched. The leaves and bracts are pale green, with the lower leaves entire, oblong, 0.5-1 cm long and the upper leaves broader, 1-2 cm long, with 1-2 pairs of small lobes. The flowers are 16-17 mm long, the lower lip with a yellowish-pubescent pouch and rounded glabrous lobes. Flowering time is from July to November.

Habitat: It is found in the intertidal zone of coastal marshes.

Occurrence at the Pittsburg and Contra Costa Power Plants and Montezuma Habitat Enhancement Site: A single population of soft bird's-beak was found during surveys conducted adjacent to the Pittsburg Power Plant in 1992. No populations of soft bird's-beak were found during surveys conducted in the vicinity of the Montezuma site in 1973-1974 (Jones & Stokes, Inc., 1975) or 1977-1978 (BioSystems Analysis, Inc., 1980)

California Black Rail (*Laterallus jamaicensis coturniculus*)

Status: The California black rail is listed as threatened by the CDFG.

Description: The California black rail is a sparrow-sized bird (about 12.5 cm total length), uniformly slate-gray overall except for variable amounts of white spotting on the back and sides, and has chestnut coloration on the nape of the neck. The bill is blackish, legs and toes blackish-brown, and the eyes are reddish-brown. Sexes are similar in appearance, and juveniles apparently differ only in more uniform coloration and less distinctive pattern.

The first known specimen of the California black rail was presented to the Smithsonian Institution in 1859 (Wilbur 1974a). The collecting locality was given as "Farallones, Cal." apparently referring to the Farallon Islands, about 30 miles west of San Francisco. No collecting date or additional data were included with the specimen. It was described by Ridgway (1874) as the Farallon rail (*Porzana jamaicensis coturniculus*). Controversy arose over the identity of the bird when black rails were discovered on the nearby California mainland. After numerous name changes, the California black rail was classified as the subspecies, *Creciscus jamaicensis coturniculus*. Peters (1934) placed the North American black rails in the genus *Laterallus*, where they remain to date.

Distribution: The California black rail historically was known or thought to occur as a breeder from the San Francisco Bay Area (including the Sacramento/San Joaquin Delta) south along the coast to northern Baja California, in the San Bernardino/Riverside area, at the Salton Sea, and along the lower Colorado River north of Yuma in California and Arizona. The coastal populations included ones at Morro Bay and San Diego. Wintering birds were found in the breeding areas and were also found at Tomales Bay. The current distribution of the California black rail differs from the historic known range; the breeding range has been reduced as a result of wetland loss. The California black rail is probably absent as a breeder from coastal and southern California and from south San Francisco Bay. They evidently breed at Morro Bay, but the breeding status in the Riverside area is unknown. Breeding birds have been identified in Tomales Bay, Bolinas Lagoon, Corte Madera Marsh, Gallinas Creek, Novato Creek, Day Island, Green Point, Midshipman Point, Ryer Island, Roe Island, San Pablo Marsh Creek, and the marshes at China Camp, Black John Slough, Petaluma River, and Sonoma Creek.

Abundance: The major breeding population appears to be in the north San Francisco Bay, where the marshes support at least 3,300 black rails (Evens et al. 1986). Evens (1987) believes it is likely that the Petaluma Marsh supports the bulk of the remaining breeding population of black rails in California, with densities of 3.89-4.46 per hectare.

Habitat and Life History: Information on the life history of California black rails is extremely limited. Although first described as birds of the coastal salt marshes, they have since been found regularly in saltwater and freshwater marshes (Wilbur 1974a). Vegetation inhabited varies from almost pure pickleweed (*Salicornia virginica*) along the coast to sedges (*Carex* sp.), saltgrass (*Distichlis spicata*), and bulrush (*Scirpus* sp.) in inland areas. They are usually found in the immediate vicinity of tidal sloughs (Manolis 1977), typically in the high wetland areas near the upper limit of tidal flooding. In sampling salt marshes to determine California black rail habitat preference, Evens (1987) found four factors useful in predicting their presence; vegetation averaging 44 cm in height, the presence of alkali heath (*Frankenia salina*), the presence of insects, and the absence of amphipods. Each of these characteristics is associated with high-elevation marsh.

Nesting occurs from March to early June (Bent 1926, Wilbur 1974a). The nest is loosely made but deeply cupped and almost always completely concealed by surrounding vegetation (Ingersoll 1909, Huey 1916, Hanna 1935). It may be placed on damp ground (Hanna 1935) or elevated in vegetation (Wilbur 1974a). Ingersoll (1909) reports nests up to 15 inches above the ground. Most appear to be only slightly above ground or at water level and may be disturbed by high tides (Wilbur 1974a). Huey (1916) observed nests rebuilt several times after high tides, and Ingersoll (1909) reports many black rail eggs floating in the marsh following high tides.

Heaton (1937b) describes California black rails as hatching one at a time, with the hatched chicks leaving the nest almost immediately, and one of the adult birds keeping all chicks together until hatching is completed. Heaton (1937a) also notes the rails' tendency to desert a nest if disturbed before laying begins and to desert "nine out of ten times" if only one egg has been laid when disturbance occurs. Similarly, Huey (1916) writes of the "astonishing ease" with which these birds abandon incomplete clutches, even if the nest is not actually molested but only approached.

California black rails glean isopods, insects, and other arthropods from the surface of mud and vegetation (Zeiner et al. 1990). The major threat to the continued existence of the California black rail in California has been, and currently is, the loss or degradation of its wetland habitat. In coastal southern California and the San Francisco Bay Area, habitat continues to be lost to filling, subsidence, changes in salinity, and sedimentation. Habitat in the Delta is threatened by decreasing water quality, flooding, and levee maintenance activities. In the San Francisco Bay area, the lack of high marsh vegetation as escape cover and nesting habitat contributes to an abnormally high rate of predation by raptors and ardeids during extreme high tides (Evens and Page 1986) and to the flooding of nests during high tides.

Occurrence at the Pittsburg and Contra Costa Power Plants and the Montezuma Habitat Enhancement Site: According to California Natural Diversity Data Base records, California black rails were last observed on Mallard Island (adjacent to the Pittsburg Power Plant) in 1977. No populations of California black rail were found during surveys conducted in the vicinity of the Montezuma site in 1973-1974 (Jones & Stokes, Inc., 1975) or 1975-1978 (Ficket 1976, BioSystems Analysis, Inc., 1980).

California Clapper Rail (*Rallus longirostris obsoletus*)

Status: The California clapper rail was declared endangered by the USFWS in 1970, and by the CDFG in 1971.

Description: The clapper rail is one of the largest species of the genus *Rallus*, measuring 32-47 cm from tip of bill to tail (Ripley 1977). It has a hen-like appearance, strong legs with long toes, a long, slightly decurved bill, and white undertail coverts that are often exposed when the bird is agitated. The California clapper rail has a cinnamon-buff colored breast and dark flanks crossed by white bars and olive-brown upper body parts.

Distribution: The salt marshes of south San Francisco Bay, including portions of San Mateo, Santa Clara, and Alameda counties, historically supported the largest populations of California clapper rails (Grinnell 1915, Grinnell and Miller 1944). Clapper rails occurred in San Francisco County prior to the 1880s (Gill 1979). Small populations also existed along western Contra Costa County (Grinnell and Wythe 1927, Grinnell and Miller 1944, and Gill 1979). The number of clapper rails along eastern Marin County apparently fluctuated from the 1880s onward (Grinnell 1915, Grinnell et al. 1918); breeding records increased after the 1920s (Grinnell and Wythe 1927, Gill 1979). Grinnell (1915) describes the species as occurring casually near Petaluma, Sonoma County. Gill (1979) discovered very few historic records for Napa Marsh in western Napa County and believed the eastern limit of the California clapper rail was Southampton Bay, Solano County, as reported by Grinnell and Miller (1944). Gill (1979) found no historic records for other parts of Solano County including Suisun Marsh.

Marshes south of San Francisco Bay in Elkhorn Slough, Monterey County, and other marshes adjacent to Monterey Bay were cited by Silliman (1915) as regularly supporting small numbers of California clapper rails. Prior to 1908, Elkhorn Slough had limited tidal access to Monterey Bay and may not have been suitable for clapper rails (Browning 1972).

There are numerous records for Tomales Bay, Marin County, and small marshes along the outer San Mateo County coast (Grinnell and Miller 1944, Gill 1979).

Outside of the San Francisco and Monterey bay areas, reports as early as 1932 stated that clapper rails nested in Humboldt Bay, Humboldt County (Gill 1979), but there are no authenticated records since 1947 (Wilbur and Tomlinson 1976). Brooks (1940) reports a possible breeding population of at least five rails considered to be California clapper rails in Morro Bay, San Luis Obispo County. Despite a 1977 record for Morro Bay (Gill 1979), Harvey (1980a) found no evidence of clapper rails there in 1979.

Since the mid-1880s, 79% or 583 km^2 of the original tidal marshlands of the San Francisco Bay Area have been eliminated through diking, filling, or conversion to salt evaporation ponds (Jones & Stokes et al. 1979). In South San Francisco Bay, clapper rail populations occur in remnant salt marshes such as Bair and Greco Islands (San Mateo County), Dumbarton Point (Alameda County), and in Santa Clara County (USFWS et al. 1984). In San Mateo County, rails can be found as far north as San Bruno Point (Gill 1979). Clapper rails can also be found in salt marshes fringing the South Bay outboard of the salt evaporation pond levees and along major tidal sloughs. Scattered remnant populations primarily occur near creek mouths in northern Alameda County, western Contra Costa County, and in eastern Marin County (USFWS et al. 1984).

In northern San Pablo Bay, clapper rails are resident and breed along the Petaluma River as far north as Schultz Creek and along most major tidal sloughs and creeks in Sonoma and Napa counties (Gill 1979). They also occur north to Bull Island on the Napa River (USFWS et al. 1984). Gill (1979) believes the Napa Marsh clapper rail population became established after 1940, when substantial decreases in freshwater inflow to the marsh resulted in a shift from a freshwater to a brackish marsh.

Gill (1979) predicts that clapper rails would extend their range into Suisun Marsh, Solano County, and northern Contra Costa County if reductions in the Sacramento-San Joaquin Delta outflow continued. Surveys by Harvey (1980a) confirmed that a population of at least 25 rails was present through the 1979 breeding season near Joice and Grizzly islands in Suisun Marsh. A late April record in 1979 at Martinez, Contra Costa County (Harvey 1980a), may also be evidence of breeding.

At least two pairs of clapper rails were discovered in Elkhorn Slough, Monterey County, during recent breeding season surveys (Harvey 1980a), and a minimum of two young were known to have been produced. This is the first verification of nesting at this location since 1972 (Varoujean 1973), but the status of this rail population is unclear. Clapper rails may still occur in Humboldt County or Morro Bay, San Luis Obispo County, as vagrants (Gill 1979).

Habitat and Life History: Throughout their distribution, California clapper rails occur within a range of salt and brackish marshes (Harvey et al. 1977). In South and Central San Francisco Bay and along the perimeter of San Pablo Bay, rails typically inhabit salt marshes dominated by pickleweed (*Salicornia virginica*) and cordgrass (*Spartina foliosa*). Other halophytes usually present include gum-plant (*Grindelia* sp.), salt grass (*Distichlis spicata*), jaumea (*Jaumea carnosa*), and alkali heath (*Frankenia salina*). Brackish water marshes supporting clapper rails occur along major sloughs and rivers of San Pablo Bay and along tidal sloughs of Suisun Marsh.

Pickleweed has become more widespread in Suisun Marsh and will increase in abundance if salinity continues to rise (Harvey et al. 1977). This, combined with changes in the invertebrate marsh fauna, may account for the recent establishment of clapper rails in the region. Within a marsh, clapper rails use networks of small tidal sloughs as foraging habitat. California clapper rails have not been recorded in nontidal marsh areas (USFWS et al. 1984).

Throughout the range of the California clapper rail, loss of upper marsh vegetation has greatly reduced available habitat. Most marshes in South San Francisco Bay are adjacent to steep earthen levees that have eliminated upper marsh vegetation and reduced available cover for rails during winter flood tides. High marsh vegetation in Suisun Marsh has also been eliminated by diking and livestock grazing. Recent estimates are for a population of as few as 300 individuals, with over 90% of the populations in south San Francisco Bay (CDFG 1991).

The California clapper rail is secretive and difficult to flush in dense vegetation, but once flushed, can frequently be closely approached. Individuals accustomed to the presence of humans, such as those at the City of Palo Alto Baylands, tolerate people on nearby boardwalks (USFWS et al. 1984). When evading discovery, rails typically freeze or run through vegetation, hunched over with their necks outstretched and plumage compacted, rather than taking flight. When flushed, clapper rails normally fly only a short distance before landing.

There is no clear evidence of migratory behavior in the California clapper rail, and the extent to which movements occur between different marshes is unknown (USFWS et al. 1984). Numerous accounts exist of juveniles dispersing widely from typical breeding habitat (USFWS et al. 1984).

Most nesting surveys of the California clapper rail have been conducted in south or central San Francisco Bay. According to DeGroot (1927), nesting begins in mid-March and extends into July. Two peaks in nesting activity occur: late April to late May and late June to early July (DeGroot 1927, Applegarth 1938, Gill 1972, and Harvey 1980b). The second nesting peak has been interpreted as late nesters (DeGroot 1927) or second attempts after initial nesting failures (Gill 1972). Estimates of clutch size range from 5.83 (Gill 1972) to 8.51 (DeGroot 1927), with observed clutch sizes ranging from 5 to 14 eggs. Both sexes share in incubation, which lasts from 23 to 29 days (Applegarth 1938, Zucca 1954). Eggs are approximately 45 mm in length and light tan or buff-colored with cinnamon-brown or dark lavender spotting concentrated at the broader end.

Clapper rails construct their nests near small tidal sloughs and use existing vegetation or drift material as a canopy over the nest platform. Cordgrass, pickleweed, gum-plant, salt grass, and drift material have been reported as providing nest canopies (Degroot 1927, Zucca 1954, Gill

1972, Harvey 1980b). Even though pickleweed was the main component of nests found by Harvey (1980b), most nests and calling pairs were within the cordgrass zones of south San Francisco Bay marshes. Gill (1972) calculated higher summer densities of rails in habitat that was dominated by cordgrass.

California clapper rails also build "brood" nests, consisting of a platform of stems without a canopy, to serve as high-tide refuges for young rails (Harvey 1980b). During breeding surveys of south San Francisco Bay and eastern Marin County, a total of 67 nests were found as close as 1.5 m and as far as 11 m from tidal sloughs ranging in width from 0.3 to 10 m. These tidal channels provide clapper rails with a protected route for movement within the marsh, as well as easily accessible foraging habitat and a nearby avenue of escape, particularly for vulnerable flightless young.

Estimates of breeding success in western clapper rail subspecies have been limited to monitoring percent hatching success or percent nest success. Predation of eggs and chicks by the Norway rat (*Rattus norvegicus*) and inundation of nests by high tides have been reported as causing nesting failure (Grinnell et al. 1918, DeGroot 1927, Applegarth 1938, Zucca 1954). Zucca (1954) found that abandoned or disrupted nests were most commonly subject to rat predation. He also believed cordgrass and gum-plant nests were disrupted by tides exceeding +6.7 ft. During the 1980 breeding season, Harvey (1980b) reported a 38% hatching success for 31 California clapper rail nests. He also found that 28 of 50 nests successfully hatched most of their eggs (56% nest success). Fledging success is unknown in the California clapper rail and is extremely difficult to estimate in any clapper rail population.

In summary, the most intensive nesting activity of the California clapper rail occurs from mid-March through July and the most heavily used portions of the San Francisco Bay salt marshes are the lower cordgrass-dominated areas within 10 m of tidal sloughs. During the winter, rails may be more widely distributed in marshes and more dependent on upper marsh vegetation for cover, particularly during extreme high tides.

The food habits of California clapper rails in south San Francisco Bay are described by Moffitt (1941), who reports that 18 rail stomachs contained 85.5% animal matter. The four major food items were the introduced horse mussel (*Ischadium demissus*), spiders, clams (*Macoma balthica*), and yellow shore crabs (*Hemigrapsus oregonensis*). Williams (1929) also reports clams as being a principal prey species, while Test and Test (1942) found amphipods in the esophagus of a California clapper rail. At the Elkhorn Slough, Monterey County, Varoujean (1973) observed rails feeding on the striped shore crab (*Pachygrapsus crassipes*). The food habits of clapper rails in upper San Pablo Bay and Suisun Marsh are unknown.

Adult clapper rails are taken by several avian predators, including the northern harrier (*Circus cyaneus*), red-tailed hawk (*Buteo jamaicensis*), and peregrine falcon (*Falco peregrinus*). Downy young and eggs are also vulnerable to predation by Norway rats (Harvey 1980b). The introduced horse mussel may cause some mortality by inadvertently trapping the bills or feet of birds that have stepped on or probed into the shell (DeGroot 1927).

Abundance: Overharvesting by commercial and sport hunting during 1850-1913 initially contributed to the depletion of the California clapper rail population (USFWS et al. 1984). After the enactment of the Migratory Bird Treaty Act in 1913, rails regained much of their abundance in the remaining San Francisco Bay marshes (Bryant 1915, Grinnell and Miller 1944). Destruction of habitat, however, continued to reduce local clapper rail populations. The lack of extensive high marsh habitat and the presence of steep earthen levees at most marshes limit potential population expansion. With its relatively limited geographical range, the California clapper rail is also vulnerable to the threats of oil spills and other sources of chemical pollution.

Occurrence at the Pittsburg and Contra Costa Power Plants and the Montezuma Habitat Enhancement Site: No California clapper rails were observed during surveys conducted in the vicinity of the Montezuma site in 1973-1974 (Jones & Stokes, Inc., 1975) or 1975-1978 (Fickett 1976, BioSystems Analysis, Inc., 1980).

California Least Tern (*Sterna antillarum browni*)

Status: The California subspecies is listed as endangered by both the USFWS and CDFG.

Description: Least terns are the smallest American terns, measuring from 21.6 to 24.1 cm long and having a wingspan of about 51 cm. The three U.S. subspecies are virtually indistinguishable morphologically and are currently distinguished by the separation of their breeding ranges (Burleigh and Lowery 1942, Massey 1976, Boyd 1983). Least terns have a black-capped crown, white forehead, black-tipped yellow bill, gray back and dorsal wings, white belly, and orange legs. Juveniles tend to have darker plumage and bill compared to adults and tend to have a dark eye stripe on their white forehead (USFWS 1984). The sexes are virtually identical.

Distribution: The California least tern is migratory, usually arriving in its breeding area during the last week of April and departing again in August (Davis 1968, Swickard 1971, Massey 1974). However, least terns have been recorded in the breeding range as early as March 13 and as late as November 24 (Sibley 1952, USFWS 1980). The historical breeding range of the California least tern has usually been described as extending along the Pacific coast from Moss Landing, Monterey County, California, to San Jose del Cabo, southern Baja California. However, since 1970, nesting sites have been recorded from San Francisco Bay south to Bahia de Quintin, Baja California (USFWS 1980). The nesting range in California has apparently always been widely discontinuous, with most of the birds nesting in southern California from Santa Barbara County south through San Diego County.

The migration routes and winter distribution of the California least tern are little known. There appears to be no confirmed records of least terns on the Pacific coast of South America, and there are only a few reports from the Pacific coast in Honduras, Guatemala, and Panama (USFWS 1980). Because several races of least terns are recognized in western Mexico and most subspecific plumage differences are observable only in breeding plumage, racial allocation of wintering birds is seldom possible without banding or special, readily discernable markings done prior to migration.

Habitat and Life History: Least terns arrive in the vicinity of the nesting areas from mid-April to early May. Some pair bonds may form before arrival in the nesting areas, others begin to form within the group almost immediately, and active courtship may be observed within the first few days after arrival (Davis 1968, Swickard 1971, Massey 1974). Courtship follows a well-defined pattern, beginning with "fish-flights," where a male carrying a fish is joined by one or two other terns in high-flying aerial display. Aerial glides (pairs flying in unison) follow. Posturing and parading on the ground occur in the late stage of courtship, with the male holding a small fish in his beak as he courts the female. During copulation, the female takes the fish from the male and eats it (Wolk 1954, Hardy 1957, Davis 1968, Massey 1974).

The least tern usually chooses its nesting location in an open expanse of light-colored sand, dirt, gravel, or dried mud close to a lagoon or an estuary where food can be obtained (Craig 1971, Swickard 1971, Massey 1974). Formerly, sandy ocean beaches were regularly used, but increased human activity on the beaches has made most of them unpreferred nesting sites. Nest have been observed on mud and sand flats back from the ocean or on manmade landfills (Longhurst 1969, Craig 1971). Least terns are colonial but do not nest in as dense concentrations as many other terns. Although nests have been found as close as 2.5 ft (Davis 1968), usual minimum distances between nests are 10-15 ft, with averages usually much greater (Wolk 1954, Hardy 1957, Massey 1974). Swickard (1971) found nest densities to be 16-18 per acre. In other instances, colonies are widely dispersed with over 300 ft between nests (USFWS 1980).

The nest is a small depression in which eggs are deposited. In sand, it is scooped out by the bird (Davis 1968, Swickard 1971, Massey 1974), but in hard substrates it may be any kind of natural or artificial depression. After the eggs are laid, the nests are often lined with shell fragments and small pebbles.

Least tern eggs measure about 31 x 24 mm and are buffy with various brownish and purplish streaks and speckles (Bent 1921, Hardy 1957, Davis 1968, Massey 1974). One to four eggs are laid, with two- to three-egg clutches being reported most often (Anderson 1970, Massey 1974). Egg laying usually occurs in the morning, and the eggs laid on consecutive days (Davis 1968, Massey 1974). The nesting season extends from approximately mid-May into early August, with most of the nests completed by mid-June (Grinnel 1868, Bent 1921, Swickard 1971). July and August nests may be renests after initial attempts have failed. Most authorities agree that least terns are capable of successfully raising only one brood per pair in a season (USFWS 1980).

Incubation, which begins with the laying of the first egg, is irregular at first but becomes steady after the clutch is completed (Davis 1968, Swickard 1971, Massey, 1974). Both parents participate, but the female initially takes a much greater part than the male (Hagar 1937, Hardy 1957, Davis 1968, Swickard 1971, Massey 1974). Extremes of 17-28 days to complete incubation have been documented (USFWS 1980).

Eggs usually hatch on consecutive days, and the chicks are initially weak and helpless. The adults brood continuously during the first day (Davis 1968), but by the second day, the chicks are strong and make short walking trips from the nest. From the third day on, they are increasingly mobile and active (Davis 1968, Massey 1974). Flight stage is reached at approximately 20 days of age, but the young birds do not become fully proficient fishers until after they migrate from the breeding grounds. Consequently, the parents continue to feed the young even after they are strong fliers (Tompkins 1959, Swickard 1971, Massey 1974).

Although California least tern colonies have sometimes suffered heavy losses of eggs and young to predators or unfavorable weather conditions, egg hatch and nestling survival are generally high. Swickard (1971), and Massey (1974) report 80-90% hatching success. Infertility appears to be a minor cause of least tern egg failure. Predators include the Norway rat, striped skunk (*Mephitus mephitus*), longtail weasel (*Mustela frenata*), common crow (*Corvus brachyrhynchos*), red fox (*Vulpes fulva*), gulls (*Larus* sp.), and domestic dogs.

Fledging rates vary greatly from colony to colony and from year to year (Swickard 1971, Massey 1974). The overall success rate (percent of eggs resulting in flying young) observed in a major colony is about 70% (Massey and Atwood 1979). Loss of tern chicks has been attributed to the American kestrel (*Falco sparverius*), loggerhead shrike (*Lanius ludovicianus*), common crow, common raven (*Corvus corax*), red fox, domestic dogs and cats, inclement weather, dehydration, and starvation.

Banded least terns have been recovered at up to 21 years of age, with 31 of 61 individuals being at least 5 years old (Massey and Atwood 1979). This suggests a relatively long life for individuals of this species. Banding studies have demonstrated that the usual age of first breeding is 3 years, but least terns occasionally breed at age 2 (USFWS 1980).

The California least tern obtains most of its food from shallow estuaries and lagoons, but colonies occasionally forage offshore in the ocean. The California least tern has not been observed eating anything but fish (Massey 1974). Fish known to be eaten, in order of importance, are northern anchovy (*Engraulis mordax*), topsmelt (*Atherinops affinis*), various surf perch (Embiotocidae), killifish (*Fundulus parvipinnis*), mosquitofish (*Gambusia affinis*), and other species (USFWS 1980).

Abundance: The loss of nesting and feeding habitat and high levels of human disturbance at remaining colonies has been responsible for the continued decline of the California least tern population. Formerly nesting in colonies of up to thousands of birds, the total number of breeders found in California in the mid-1970s was only about 600 pairs (CDFG 1991). During the past decade, population status has been stable. Through protection and site management, they increased from about 800 pairs in 1978 to 1,200-1,300 in 1983 (CDFG 1991). They declined to about 1,000 pairs from 1984 to 1987, possibly because of a reduced forage supply caused by El Nino conditions. The population increased again to about 1,200-1,300 pairs in

1988-1990, distributed in 28-29 colonies in the San Francisco Bay Area and from San Luis Obispo County to the Mexican border (CDFG 1991). Habitat preservation, restoration, and creation, along with nesting colony protection, are the major objectives identified by the USFWS California Least Tern Recovery Plan.

Occurrence at the Pittsburg and Contra Costa Power Plants: California least terns have been nesting at the Pittsburg Power Plant (along the access road to the Unit 7 cooling towers within the cooling water canal) since at least 1984. In 1994, two nesting pair produced three young. In 1995, three pair fledged two chicks, and four pair fledged four chicks in 1996.

Salt Marsh Harvest Mouse (*Reithrodontomys raviventris*)

Status: The salt marsh harvest mouse was declared endangered by the USFWS in 1970 and by the CDFG in 1971.

Description: Salt marsh harvest mice are small native rodents that look like the much more widely distributed western harvest mouse (*Reithrodontomys megalotis*) from which they may have evolved (Fisler 1965). There are two subspecies, the northern (*R. raviventris halicoetes*) in the marshes of the San Pablo and Suisun bays and the southern (*R. r. raviventris*) in the marshes of Corte Madera, Richmond and south San Francisco Bay.

Salt marsh harvest mice are very small cricetid rodents, weighing an average of 10 grams. This mouse has a head and body length of 69-74 mm, a tail length of 65-82 mm, a tail to body ratio of 94-125% and a hind foot length of 17-18 mm (Fisler 1965). When compared to western harvest mice, salt marsh harvest mice have darker ears and backs; lightly thicker, less pointed, and more unicolored tails; and often darker colored bellies. Most representatives of the northern subspecies have whitish bellies. Animals found in the Suisun Bay region have tails that are longer than their head and body lengths. Most individuals of the southern subspecies have cinnamon-colored bellies and shorter tails than their head and body lengths. The cinnamon or rufous-colored venter of these southern forms gave rise to the name "red-bellied" harvest mouse, an interesting but inappropriate name for the species as a whole.

It is difficult to differentiate between salt marsh and western harvest mice in the field. Identifying characteristics include the general body color, color of the ventral hairs, thickness and shape of the tip of the tail, tail/body ratios, and behavior (Fisler 1965, Shellhammer 1981). Tail length and venter coloration show clinal variation throughout the range of the species. The only significant cranial difference between the two subspecies is the depth of the brain case (Fisler 1965).

Distribution: Salt marsh harvest mice evolved with the creation of San Francisco Bay some 8,000-25,000 years ago. According to Fisler (1965), these mice were found in most of the marshes throughout San Francisco Bay. The wetlands and marshes of the original Sacramento-San Joaquin Delta were probably too fresh to support mice, and hence, the Collinsville-Antioch area probably was, and still is, the eastern limit of their distribution. During the last 200 years, approximately 79% of the tidal marshes of San Francisco Bay have been filled, flooded, or converted to other types of vegetation (Jones & Stokes, Inc. et al. 1979). A large area has been converted to diked wetland, most of which is marginal or inappropriate habitat for harvest mice.

Most of the remaining tidal marshes are fragmented strips situated along outboard dikes and along sloughs often separated from one another by considerable distances.

The western limit of the northern subspecies is the marshes bordering the mouth of Gallinas Creek on the upper Marin Peninsula. Narrow strips of marshes extend northward into and along the Petaluma River and connect to the large Petaluma Marsh. Lower Tubbs Island, further east along San Pablo Bay, is being restored to tidal action by the USFWS and will provide a sizable marsh in the future. Many of the marshes in the Napa Marsh are too narrow and steep to support salt marsh harvest mice, although mice are present along Napa Slough and Sonoma Creek, on Coon Island, and in the Fagan Marsh. The marsh along San Pablo Bay from Sonoma Creek to Mare Island is naturally expanding from sediment accretion and is one of the major refugia for this species in San Pablo Bay. It is the principal marsh within the San Pablo Bay National Wildlife Refuge.

Repeated trapping in the Southampton Bay Marsh failed to capture any harvest mice; the next populations east of Mare Island are in Suisun Marsh. This huge wetland is managed primarily as waterfowl habitat and, until recently, to enhance alkali bulrush (*Scirpus robustus*), once considered a preferred food for mallard (*Anas platyrhynchos*) and pintail (*A. acuta*). Salt marsh harvest mice in this wetland are present in low numbers in pickleweed (*Salicornia virginica*) areas that are scattered among the alkali bulrush. Moderate populations of mice occur in the diked marshes near Collinsville and in diked and tidal marshes along the Contra Costa County coast.

Habitat and Life History: Salt marsh harvest mice are critically dependent on dense cover and their preferred habitat is pickleweed (Fisler 1965; Wondolleck et al. 1976; Shellhammer 1977, 1981). Harvest mice are seldom found in cordgrass (*Spartina foliosa*) or alkali bulrush (Fisler 1965, Wondolleck et al. 1976, Shellhammer 1977, Harvey and Stanley Associates 1980, Shellhammer 1981, Shellhammer et al. 1982). In marshes with an upper zone of peripheral halophytes, mice use the vegetation to escape the higher tides and may even spend a considerable portion of their lives there. Fisler (1965) notes that mice also move into the adjoining grasslands during the highest winter tides.

Throughout much of the range of the salt marsh harvest mouse, subsidence and diking have eliminated the important peripheral halophyte zone. This is especially evident around south San Francisco Bay. Few harvest mice survive in such marshes, even though other marsh conditions may be optimal, because there is little or no high tide escape cover.

Studies have shown that the best type of pickleweed association for harvest mice has 100% ground cover, a cover depth of 30-50 cm at summer maximum, 60% or more of pickleweed cover, and complexity in the form of fat hen (*Atriplex patula*) and alkali heath (*Frankenia salina*) or other halophytes (USFWS et al. 1984).

The amount of salt grass (*Distichlis spicata*), brass buttons (*Cotula coronopifolia*), alkali bulrush, or other species (*Typha* sp., *Scirpus* sp.) should be low. These species may be present, but not in large continuous stands. Salt grass and brass buttons provide very poor habitat for harvest mice. They are low-growing, lack stratification, and provide poor cover. Fat hen provides good cover for mice during the summer but cannot be used year-round because it is an annual.

Salt marsh harvest mice are placid in comparison to western harvest mice or house mice. Their temperament correlates with their habitat. The much more active western harvest mice live in more open environments and use their quickness to escape predators (Fisler 1965). The less active salt marsh harvest mouse is so dependent on cover that roads or open areas as small as 10 m wide appear to act as barriers to movement (Shellhammer 1978). These behavioral differences are so great that they are useful in field identification (Fisler 1965, Shellhammer 1981).

Salt marsh harvest mice swim well, floating on the surface "like corks" (Fisler 1965). The western harvest mouse swims violently and poorly, and its fur becomes rapidly wetted. Salt marsh harvest mice do not burrow. The northern subspecies may build nests or cap over old bird nests (Fisler 1965), but the southern form often does not build a nest at all. Nests are often a loose ball of grasses on the surface of the ground and may be abandoned with the next high tide.

Salt marsh harvest mice are partly diurnal. Fisler (1965) suggests that the most placid and least nocturnal individuals live in the densest cover.

According to Fisler (1965), male harvest mice are reproductively active from April through September, although some males appear reproductively active year-long. Although females have a long breeding season that extends from as early as March to November, they apparently have a low reproductive potential. This may be due to the relatively small average litter, between 3.72 and 4.21 (Fisler 1965), and the fact that females do not have many litters per year. Fisler (1965) estimates that females of the northern subspecies may have only one litter per year.

Fisler (1965) notes that salt marsh harvest mice eat green vegetation in addition to seeds. They have longer intestines than the western harvest mouse, which is a seed eater. The northern subspecies of the salt marsh harvest mouse can drink seawater for long periods of time but prefers to drink freshwater. The southern subspecies is unable to drink seawater as its only drinking fluid but prefers moderately saline water (Fisler 1965). These preferences correlate with the habitats that these forms occupy. The northern subspecies typically lives in more brackish marshes where the range of salinities is wide, but the average is not very saline. The southern subspecies lives in marshes where the average salinity is relatively high and stable. The effect of salinity on the diet of these mice is only partially understood (Fisler 1963, Haines 1964, Coulombe 1970) but may be a critical factor in their management.

Little is known about the natural causes of mortality in this species. Snakes, owls, hawks, and various other potential predators inhabit most marshes, but their impact is not known.

Abundance: There are five principal reasons for the decline of the salt marsh harvest mouse: habitat loss, fragmentation of the remaining marshes, widespread loss of the high marsh zone as a result of backfilling, land subsidence, and vegetational change (USFWS et al. 1984).

The present status of the salt marsh harvest mouse appears to be a few thousand animals at the peak of their numbers each summer, distributed around San Francisco Bay marshes in small, disjunct populations, often in marginal vegetation and almost always in marshes without an upper edge of upland vegetation (USFWS et al. 1984).

Occurrence at the Pittsburg and Contra Costa Power Plants and the Montezuma Habitat Enhancement Site: Live trapping studies conducted in 1978 at the Pittsburg Power Plant property revealed the presence of salt marsh harvest mice (WESCO 1979). The draft revised California Clapper Rail/Salt Marsh Harvest Mouse Recovery Plan targets areas along Suisun Bay on the Pittsburg site as essential habitat.

Surveys conducted at the Montezuma Enhancement Site between October 1977 and August 1978 (Biosystems Analysis, Inc. 1980) resulted in detection of salt marsh harvest mouse. However, no salt marsh harvest mice have been detected since that time, including a 1994 survey that involved 75 trap nights. Salt marsh harvest mouse habitat has declined at the site in the past 20 years and only 9.78 acres of suitable habitat remained in 1996.

The 1984 California Clapper Rail/Salt Marsh Harvest Mouse Recovery Plan identified the Montezuma Enhancement Site as a "Priority 3" essential habitat area to be managed as a diked marsh. However, the draft revised plan no longer includes this area as essential habitat.

No sensitive terrestrial species are known to occur on the Contra Costa site.

APPENDIX B. PREVIOUS AQUATIC MONITORING PROGRAMS

A variety of investigations have been performed at the Pittsburg and Contra Costa power plants to characterize fish losses resulting from circulating water system operations, and identify and implement measures to minimize these losses. Operation of a power plant's circulating water system has the potential for impacting aquatic organisms through entrainment, impingement, and exposure to elevated water temperatures within the thermal discharge plume. Estimated numbers of the sensitive species entrained and impinged at the power plants are summarized below based on results of monitoring performed in 1978/1979 [316 (b) evaluations] and in 1986-1992 (striped bass monitoring program). Although these monitoring programs focused on striped bass, they provide additional information on entrainment and impingement of Delta smelt, longfin smelt, Sacramento splittail, chinook salmon, steelhead, and green sturgeon. The data are used in combination with monitoring data on circulating water system operations (circulating water pump operations) to estimate the numbers of each fish species entrained and impinged during the monitoring period.

These studies were conducted to comply with National Pollution Discharge Elimination System permit provisions issued by the Regional Water Quality Control Boards for the operation and monitoring of a cooling water system at both power plants. These programs have been conducted cooperatively with the San Francisco Bay and Central Valley Regional Water Quality Control Board, the California Department of Fish and Game (CDFG), the U.S. Fish and Wildlife Service (USFWS), and the National Marine Fisheries Service (NMFS). To minimize impacts identified during these evaluations, significant modifications to equipment and operations have been incorporated at the Pittsburg and Contra Costa power plants. These modifications are discussed below.

B-1.0 ENTRAINMENT

Entrainment is the hydraulic capture and subsequent passage of organisms through the cooling water system. The organisms involved are small (typically, less than 20 mm long), unable to avoid the screens, and capable of passing through the 3/8-inch mesh of the intake screens and include eggs, larvae, and early juvenile stages of various fish species. As these entrained organisms pass through the cooling water system, they can be exposed to several types of stresses. These include mechanical, pressure, shear, thermal, and chemical stresses. The potential impact of entrainment is a function of the number of organisms that do not survive passage through the cooling water system.

B-1.1 Entrainment Investigations Prior to 1982

Entrainment studies were conducted at the Pittsburg and Contra Costa power plants in 1978/1979 as part of the 316(b) demonstration program (PG&E 1981a, b). The studies provided detailed information on species composition, numbers of various fish and macroinvertebrates entrained at the cooling water intakes, the size distribution of organisms, the diel distribution, and seasonal patterns. In addition, detailed studies were also conducted to determine the survival of organisms, primarily larval striped bass and mysid shrimp, entrained through the cooling water system and to separate the influence of mechanical and thermal stress as factors influencing entrainment survival. The entrainment studies were conducted during a 16-month period in 1978 and 1979 and provided the baseline information for subsequent entrainment monitoring. Entrainment monitoring was conducted at a sampling frequency of one 24-hour sampling period per week. As a consequence of the inability to taxonomically differentiate between larval longfin smelt and Delta smelt, results of entrainment monitoring performed during these studies were combined and reported in most cases only as smelt (*Osmeridae*).

Based on results of entrainment monitoring, estimates of the annual numbers of larval fish and eggs entrained at the two power plants were calculated based on actual circulating water system operations. However, these entrainment estimates do not consider survival of entrained organisms returned to the receiving waters. The estimated numbers of entrained larval Delta smelt, longfin smelt, Osmeridae, Sacramento splittail, chinook salmon, steelhead, and green sturgeon are summarized in Table B-1.

Table B-1. Total Number of Fish Collected and Estimated Annual Entrainment at the Pittsburg and Contra Costa Power Plants (1978/1979)

	Delta Smelt	Longfin Smelt	Osmeridae	Sacramento Splittail	Chinook Salmon	Steelhead	Green Sturgeon
PITTSBURG POWER PLANT							
Number of fish collected[1]	46	13	2,278	16	1	0	0
Estimated annual entrainment[2]	455,413 ±184,516	190,229 ±198,009	64,784,071 ±29,475,225	155,289 ±60,064	23,598 ±35,468	0	0
CONTRA COSTA POWER PLANT							
Number of fish collected[1]	4	0	1,518	34	2	0	0
Estimated annual entrainment[2]	21,887 ±23,881	0	20,543,854 ±5,601,594	189,659 ±118,820	10,318 ±18,820	0	0

[1] Represents total number of fish collected during entire study period.
[2] Estimated annual entrainment based on design flow and includes 95% confidence interval.

Based on examination of the length frequency data from these entrainment samples, it was estimated that 94% of the entrained smelt at the Pittsburg Power Plant ranged from 5 to 7 mm in length. The significance of the 1978/1979 smelt entrainment loss estimate (which does not consider entrainment survival) on the resulting recruitment of adult smelt may be substantially reduced by the small size of entrained larvae and high natural mortality rates. Most of the larvae were collected in the January-February period, which is somewhat early for Delta smelt. This, coupled with the high ratio of longfin smelt to Delta smelt found in the impingement results at the Pittsburg Power Plant suggest that most of the entrained larvae may have been longfin smelt.

B-1.2 Entrainment Investigations from 1986 through 1992

As part of the program to reduce striped bass entrainment losses, striped bass entrainment monitoring was performed at both power plants from 1986-1992. Each year, entrainment monitoring commenced May 1 and typically continued to mid-July. The estimated number of entrained *Osmeridae* (both Delta and longfin smelt combined), Delta smelt, longfin smelt, Sacramento splittail, chinook salmon, steelhead, and green sturgeon are summarized in Table B-2. During the early period of this entrainment monitoring program (1986-1989), larval Delta smelt and longfin smelt could not be taxonomically differentiated with confidence and, therefore, results of these collections have been combined and recorded as *Osmeridae*. Beginning in 1990, taxonomic identification of larval delta smelt and longfin smelt improved, and the two species have been recorded separately.

Table B-2. Total Number of Fish Collected and Estimated Annual Entrainment at the Pittsburg and Contra Costa Power Plants (1986-1992) [1]

	Delta Smelt	Longfin Smelt	Osmeridae	Sacramento Splittail	Chinook Salmon	Steelhead	Green Sturgeon
PITTSBURG POWER PLANT							
Number of fish collected[2]	4	18	126	26	0	0	0
Estimated annual entrainment[3]	51,698 ±50,644	232,641 ±133,854	1,628,489 ±1,388,542	336,037 ±147,334	0	0	0
CONTRA COSTA POWER PLANT							
Number of fish collected[2]	4	6	128	8	0	0	0
Estimated annual entrainment[3]	47,453 ±46,485	71,179 ±56,917	1,518,480 ±1,712,930	94,905 ±65,705	0	0	0

[1] Data collected from May 1 - July 15.
[2] Represents total number of fish collected during the 7-year study period.
[3] Estimated annual entrainment based on densities over the May-July sampling period and on design flow for 12 months, and includes 95% confidence interval.

To estimate the total numbers of each species entrained annually at the Contra Costa and Pittsburg power plants results of individual collections reported on Table 3-6 were converted to an average density estimate (number /m^3) and combined with data on cooling water flow (m^3 during each week) to estimate the total numbers of organisms entrained.

Entrainment survival data for larval striped bass (PG&E 1981a, b) and other larval fish generally indicate a strong relationship between temperature and survival. However, because entrainment survival data are not available for Delta smelt, longfin smelt, Sacramento splittail, chinook salmon, steelhead, and green sturgeon, 100% entrainment loss must be assumed. The significance of estimates of entrainment loss of fish larvae on populations of Delta smelt, longfin smelt, Sacramento splittail, chinook salmon, steelhead, and green sturgeon inhabiting the Bay/Delta system is difficult to assess.

Results of entrainment monitoring have shown that the numbers of Delta smelt, longfin smelt, and Sacramento splittail lost after modifications to plant equipment and operations have been generally reduced when compared to pre-modification data.

B-2.0 IMPINGEMENT

Impingement occurs when an organism is held against the intake screens used to remove debris from the cooling water. Fish susceptible to impingement are typically large juveniles and adults (typically greater than 38 mm long) that have died from other causes or are in a weakened condition. The survival of impinged fish depends on the species, lifestage, and size of the organism. Other factors influencing impingement survival include the duration of impingement and the techniques of handling impinged organisms and returning them to the water body, as well as seasonal water body characteristics, such as salinity, water temperature, etc.

B-2.1 Impingement Investigations prior to 1982

The first investigations were performed at the Contra Costa Power Plant Units 1-5 intake during the early 1950's (Kerr 1953). The objective of these early studies was to modify the Units 1-5 intake system to minimize the numbers of fish impinged. As a result of these early investigations, an effective fish pump removal system designed to remove fish from the area in front of the screens was installed at the Units 1-5 intake. The fish pump was effective in substantially reducing the numbers of fish impinged while maintaining high survival rates for those fish removed from the intake and returned to the water body (Kerr 1953, PG&E 1981a). In addition, based on results of the early investigations, Kerr (1953) developed design criteria for cooling water intake structures to minimize and avoid fish impingement. The recommended design criteria (e.g., intake approach velocities, configuration of the intake structure including lateral fish escape routes and intake screens located parallel to the shoreline, and avoidance of recessed intake configurations where fish may become entrapped) were used in the design of the

Contra Costa Units 6 and 7 and Pittsburg Units 1-7 cooling water intake structures and have been recognized nationally as the recommended design for power plant once-through cooling water systems (EPA 1977).

Impingement survival studies were also conducted for various fish and macroinvertebrate species to determine the effects of alternative intake screen operational modes (frequency of intake screen rotation and duration of impingement) and to document the effectiveness and survival of fish removed from the Contra Costa Units 1-5 intake through the fish pump return system.

The estimated numbers of Delta smelt, longfin smelt, Sacramento splittail, chinook salmon, steelhead, and green sturgeon impinged at each cooling water intake structure at both power plants were also estimated based on actual cooling water system operations. Results of annual impingement estimates are summarized in Table B-3.

Table B-3. Total Number of Fish Collected and Estimated Annual Impingement at PG&E's Delta Power Plants (1978/1979)

	Delta Smelt	Longfin Smelt	Osmeridae	Sacramento Splittail	Chinook Salmon	Steelhead	Green Sturgeon
PITTSBURG POWER PLANT							
Number of fish collected[1]	1,490	13,466	3	1,517	141	0	0
Estimated annual impingement[2]	14,082 ± 6,454	137,261 ± 55,576	25 ±29	8,732 ± 4,596	808 ±331	0	0
CONTRA COSTA POWER PLANT							
Number of fish collected[1]	1,747	1,275	0	1,792	176	0	1
Estimated annual impingement[2]	8,253 ±1,595	19,475 ±11,758	0	12,455 ±3,422	763 ±316	0	0

[1] Represents total number of fish collected during entire study period.
[2] Estimated annual impingement based on design flow and includes 95% confidence interval.

Even though individual lengths of the chinook salmon collected during the 316(b) impingement studies for the Pittsburg Power Plant are not available, monthly length ranges were recorded in Appendix E of the 316(b) Demonstration (Ecological Analysts, Inc. 1981a). The monthly totals and length ranges for the fish collected during the 1978-79 impingement sampling, and the length categories for the different run types are shown in Table B-4. The "X" values in the columns indicate the groups of fish that fall into each run category. Because each fish could fall into one or more run categories, the sum of the maximum number by run is greater than the actual number collected.

Table B-4. Total Number and Length Ranges of Chinook Salmon Collected during Impingement Sampling at the Pittsburg Power Plant (March 1978 - March 1979) and Salmon Run Categories based on Length and Month of Capture

MONTH & YEAR OF CAPTURE	Number of fish collected	Length range of fish collected (mm)	Chinook salmon run categories (mm) (from CDFG 1991 unpublished data, Frank Fisher)					
			Winter-run		Spring-run		Fall/late fall-run[1]	
MAR 78	0		81-199		60-99		0-73, 164-270	
APR 78	14	48-85	99-243		73-120	X[2]	0-89, 201-270	X
MAY 78	3	59-72	121-270		89-147		0-109, 244-270	X
JUN 78	8	60-88	148-270		110-179		0-133	X
JUL 78	3	57-80	0-40, 181-270		133-220		33-163	X
AUG 78	0		0-50, 221-270		164-269		41-199	
SEP 78	0		0-60		201-270		50-243	
OCT 78	0		0-74		0-37,244-270		61-270	
NOV 78	5	73-108	37-90	X	0-45		74-270	X
DEC 78	9	120-181	45-110		33-55		0-33, 91-201	X
JAN 79	10	43-258	55-135	X	41-67	X	0-50, 111-246	X
FEB 79	16	32-83	67-163	X	50-80	X	0-59, 136-270	X
MAR 79	20	42-128	81-199	X	60-99	X	0-73, 164-270	X
APR 79	12	57-106	99-243	X	73-120	X	0-89, 201-270	X
MAY 79	18	60-103	121-270		89-147	X	0-109, 244-270	X
JUN 79	13	71-90	148-270		110-179		0-133	X
JUL 79	10	60-91	181-270, 0-40		133-220		33-163	X
AUG 79	0		221-270, 0-50		164-269		41-199	
SEP 79	0		0-60		201-270		50-243	
OCT 79	0		0-74		0-37, 244-270		61-270	
NOV 79	0		37-90		0-45		74-270	
			Maximum Number and Percentage of Total Collected[3]					
			Winter-run		Spring-run		Fall/late fall-run	
			#	%	#	%	#	%
TOTAL	141		57	40	82	58	136	96

1 Late fall and fall-run categories were combined to create this category.
2 Individual lengths of salmon collected during the 1978-79 studies were not retrievable. Using the length ranges of the salmon collected , the "X" values in the columns indicate the groups of fish that fall into the various run categories based on length and date of capture. The table used to group these fish was developed from analyses conducted by Frank Fisher of CDFG (1991 unpublished data). This table was attached to the 1995 CDFG Memorandum of Understanding (MOU) for PG&E's fisheries sampling at the Pittsburg and Contra Costa power plants.
3 The maximum number of fish and % of the total number from the 1978-79 studies that could fall into the various run types are shown at the bottom of the table.

Even though individual lengths of the chinook salmon collected during the 316(b) impingement studies for the Contra Costa Power Plant are not available, monthly length ranges were recorded in Appendix E of the "Cooling Water Intake Structure 316(b) Demonstration" (Ecological Analysts, Inc. 1981b). The monthly totals and length ranges for the fish collected during the 1978-79 impingement sampling, and the length categories for the different run types are shown in Table B-5 for Units 1-7 and Table B-6 for Units 6&7. The "X" values in the columns indicate the groups of fish that fall into each run category. Because each fish could fall into one or more run categories, the sum of the maximum number by run is greater than the actual number collected.

Table B-5. Total Number and Length Ranges of Chinook Salmon Collected during Impingement Sampling for Units 1-7 at the Contra Costa Power Plant (April 1978 - January 1980) and Salmon Run Categories based on Length and Month of Capture

MONTH & YEAR OF CAPTURE	Number of fish collected	Length range of fish collected (mm)	Chinook salmon run categories (mm) (from CDFG 1991 unpublished data, Frank Fisher)					
			Winter-run		Spring-run		Fall/late fall-run[1]	
APR 78	15	55-83	99-243		73-120	X[2]	0-89	X
MAY 78	12	67-88	121-270		89-147		0-109	X
JUN 78	41	58-102	148-270		110-179		0-133	X
JUL 78			0-40		133-220		33-163	
AUG 78			0-50		164-269		41-199	
SEP 78			0-60		201-270		50-243	
OCT 78			0-74		0-37, 244-270		61-270	
NOV 78	2	106-159	37-90		0-45		74-270	X
DEC 78	5	101-163	45-110	X	33-55		0-40, 91-270	X
JAN 79	1	120	55-135	X	41-67		0-50, 111-270	X
FEB 79	3	40-108	67-163	X	50-80	X	0-59, 136-270	X
MAR 79	5	58-94	81-199	X	60-99	X	0-73, 164-270	X
APR 79	6	70-86	99-243		73-120	X	0-89, 201-270	X
MAY 79	16	72-92	121-270		89-147	X	0-109, 244-270	X
JUN 79	25	65-110	148-270		110-179	X	0-133	X
JUL 79	12	69-100	181-270, 0-40		133-220		33-163	X
AUG 79			221-270,0-50		164-269		41-199	
SEP 79	1	82	0-60		201-270		50-243	X
OCT 79	4	141-162	0-74		244-270 0-37		61-270	X
NOV79	25	95-187	37-90		0-45		74-270	X
DEC 79	2	111-123	45-110		33-55		0-40, 91-270	X
JAN 80	1	128	55-135	X	41-67		0-50, 111-270	X
			Maximum Number and Percentage of Total Collected[3]					
			Winter-run		Spring-run		Fall/late fall-run	
			#	%	#	%	#	%
TOTAL	176		12	7	63	36	174	98

[1] Late fall and fall-run categories were combined to create this classification.

[2] Individual lengths of salmon collected during the 1978-79 studies were not retrievable. Using the length ranges of the salmon collected, the "X" values in the columns indicate the groups of fish that fall into the various run categories based on length and date of capture. The table used to group these fish was developed from analyses conducted by Frank Fisher of CDFG (1991 unpublished data). This table was attached to the 1995 CDFG Memorandum of Understanding (MOU) for PG&E's fisheries sampling at the Pittsburg and Contra Costa power plants.

[3] The maximum number of fish and percentage of the total from the 1978-79 studies that could fall into the various run types are shown at the bottom of the table.

Table B-6. Total Number and Length Ranges of Chinook Salmon Collected during Impingement Sampling for Units 6&7 at the Contra Costa Power Plant (April 1978 - January 1980) and Salmon Run Categories based on Length and Month of Capture

MONTH & YEAR OF CAPTURE	Number of fish collected	Length range of fish collected (mm)	Chinook salmon run categories (mm) (from CDFG 1991 unpublished data, Frank Fisher)					
			Winter-run		**Spring-run**		**Fall/late fall-run**[1]	
APR 78	13	55-83	99-243		73-120	X[2]	0-89	X
MAY 78	10	67-83	121-270		89-147		0-109	X
JUN 78	10	64-98	148-270		110-179		0-133	X
JUL 78			0-40		133-220		33-163	
AUG78			0-50		164-269		41-199	
SEP 78			0-60		201-270		50-243	
OCT 78			0-74		0-37, 244-270		61-270	
NOV 78			37-90		0-45		74-270	
DEC 78			45-110		33-55		0-40, 91-270	
JAN 79			55-135		41-67		0-50, 111-270	
FEB 79	3	40-108	67-163	X	50-80	X	0-59, 136-270	X
MAR 79	1	58	81-199		60-99		0-73, 164-270	X
APR 79	3	70-75	99-243		73-120	X	0-89, 201-270	X
MAY 79	14	72-92	121-270		89-147	X	0-109, 244-270	X
JUN 79	14	65-110	148-270		110-179	X	0-133	X
JUL 79	9	69-100	181-270, 0-40		133-220		33-163	X
AUG 79			221-270, 0-50		164-269		41-199	
SEP 79			0-60		201-270		50-243	
OCT 79			0-74		244-270, 0-37		61-270	
NOV 79	3	119-151	37-90		0-45		74-270	X
DEC 79			45-110		33-55		0-40, 91-270	
JAN 80			55-135		41-67		0-50, 91-270	
			Maximum Number and Percentage of Total Collected[3]					
			Winter-run		**Spring-run**		**Fall/late fall-run**	
			#	%	#	%	#	%
TOTAL	80		2	3	42	53	79	99

[1] Late fall and fall-run categories were combined to create this classification.

[2] Individual lengths of salmon collected during the 1978-1979 studies were not retrievable. Using the length ranges of the salmon collected, the "X" values in the columns indicte the groups of fish that fall into the various run categories based on length and date of capture. The table used to group these fish was developed from analyses conducted by Frank Fisher of CDFG (1991 unpublished data). This [illegible]le was attached to the 1995 CDFG Memorandum of Understanding (MOU) for PG&E's fisheries sampling at the Pittsburg and Contra Costa Power Plants.

[3] The maximum number of fish and percentage of the total from the 1978-1979 studies that could fall into the various run types are shown at the bottom of the table.

B-2.2 Impingement Investigations from 1987 through 1990

Impingement monitoring was performed at cooling water intakes for both power plants over 3 years from 1987 through 1990. In general, the impingement sampling was done once a month from August through February. The number of *Osmeridae*, Delta smelt, longfin smelt, Sacramento splittail, chinook salmon, steelhead, and green sturgeon collected in impingement samples during each of these periods is summarized in Table B-7. Unlike entrainment monitoring where a relatively small volume of cooling water is sampled, impingement samples reflect all fish impinged during the period of sampling. No green sturgeon were collected during the 3 years at both power plants, and only three chinook salmon were collected during the same period. The numbers of Delta smelt (26) and Sacramento splittail (23) collected during these impingement samples were also relatively low. The numbers of longfin smelt collected, particularly during the 1987/1988 surveys were substantially higher at the Pittsburg Power Plant (359) than numbers collected at the Contra Cost Power Plant (7).

Table B-7. Total Number of Fish Collected and Estimated Annual Impingement at the Pittsburg and Contra Costa Power Plants (1987-1990) [1]

	Delta Smelt	Longfin Smelt	Osmeridae	Sacramento Splittail	Chinook Salmon	Steelhead	Green Sturgeon
PITTSBURG POWER PLANT							
Number of fish collected[2]	8	359	0	6	3	0	0
Estimated annual impingement[3]	283 ±1,003	12,677 ±46,052	0	212 ±513	106 ±517	0	0
CONTRA COSTA POWER PLANT							
Number of fish collected[2]	18	7	0	17	0	0	0
Estimated annual impingement[3]	942 ±2,125	366 ±1,768	0	889 ±2,136	0	0	0

[1] Data collected from August 1 - February 28.
[2] Represents total number of fish collected during study period.
[3] Estimated annual impingement based on densities established in the August-February sampling and on design flow for 12 months, and includes 95% confidence interval.

Results of impingement monitoring have been used (based on actual cooling water volumes) to estimate the total numbers of each species impinged during the period when monitoring data are available. Because of their sensitivity to handling and stress, impingement loss estimates for Delta smelt, longfin smelt, Sacramento splittail, and chinook salmon have been made based on the assumption of 100% impingement mortality.

Results of impingement monitoring have shown that the numbers of Delta smelt, longfin smelt, Sacramento splittail, chinook salmon, steelhead, and green sturgeon lost after modifications to plant equipment and operations have been low.

B-3.0 POWER PLANT MODIFICATIONS TO REDUCE ENTRAINMENT AND IMPINGEMENT LOSSES

As a result of the relatively large entrainment and impingement losses documented in the 1978/1979 studies at both power plants, an assessment of design and operational modifications to the plants to reduce fishery losses was conducted. The evaluation of alternative technologies (Tera 1982) included consideration of 43 structural and operational modifications designed to reduce the numbers of fish entrained and impinged through cooling water volume reduction and improving the survival of organisms that are entrained or impinged. The resulting best technology available (BTA) program incorporated a variety of structural and operational changes to cooling water system operations. These included:

- Variable speed circulating water pump controls for Contra Costa Units 6 and 7 and Pittsburg Units 5 and 6.
- Seasonal program of preferential operation of Pittsburg Unit 7, which is equipped with mechanical draft cooling towers.
- Operation and dispatch of units during spring (typically May through mid-July) to reduce, to the extent possible, unit operations, cooling water flows, and the frequency of discharge temperatures exceeding 86°F.
- Entrainment monitoring to determine the appropriate period for implementing operational changes based on seasonal patterns in the densities of larval striped bass.
- Entrainment monitoring to dispatch units based on the geographic distribution of larval striped bass and in a method for evaluating the effectiveness of various actions in reducing larval striped bass losses.

In 1985, the performance of measures implemented at the two power plants was re-examined and additional modifications were recommended to further reduce fisheries losses (TENERA 1985). Based on results of this re-examination, additional modifications to the cooling water systems at the Contra Costa and Pittsburg power plants were performed, including the following:

- Installation of variable-speed circulating water pump controls at Contra Costa Units 4 and 5 and Pittsburg Units 1-4.
- Operation of mechanical crossovers to reduce cooling water volumes at Contra Costa Units 1-3.
- Installation of a hydrogen cooler at Contra Costa Units 6 and 7.

In 1991, a re-examination of alternative technologies to reduce fisheries losses at the two power plants was again conducted. The re-examination was performed to determine if new or improved technologies had been developed since completing the 1985 review (TENERA 1985). Results of the 1991 re-examination (PG&E 1992) were reviewed by the CDFG and the USFWS and were submitted to the San Francisco and Central Valley Regional Water Quality Control Boards. It was concluded that the design and operational changes implemented at the Contra Costa and

Pittsburg power plants have been effective in reducing fisheries losses, and no additional design modifications were identified or required.

B-4.0 THERMAL EFFECTS

Potential effects associated with exposure to power plant thermal discharge plumes include behavioral avoidance of potential habitat, behavioral attraction, increased susceptibility to predation, sublethal stresses resulting in reduced health and fitness, and potential acute mortality as a consequence of exposure to elevated temperatures. The response of a fish species to the thermal discharge plume varies depending on the thermal tolerance and physiology of the species, its lifestage, acclimation temperature, the duration of exposure, the difference in temperatures between the acclimation temperature and the exposure temperature (delta-T), and the absolute temperature to which the organisms are exposed. Factors such as the geographic distribution of the thermal plume, the vertical distribution of the plume within the water column, mixing characteristics, the thermal dissipation (temperature decay), and the configuration and characteristics of discharge are important factors affecting the potential biological significance of exposure to the discharge.

Pittsburg and Contra Costa power plant investigations to address thermal impacts of the discharges have not identified any adverse effects associated with exposure of fish to temperatures occurring within the thermal discharge plumes. These studies include 316 (a) studies that were completed in the mid-1970s and the recent 1991/1992 Thermal Effects Assessment (PG&E 1992). Results of field data collection efforts, particularly the 1991/1992 evaluation, have been characterized by low, or highly variable abundances of many target species, including longfin and Delta smelt near the power plants. The populations of many of the native fishes have been low in areas both within and outside of the discharge plume, which is consistent with the documented decline in abundance of these native species through the 1980s. Even though Sacramento splittail have also decreased throughout the estuary, splittail have been commonly collected within both areas exposed to the discharge plumes and at reference locations, demonstrating no apparent avoidance of the discharge areas. The discharge areas associated with both power plants support diverse fisheries communities and, with the exception of the area within the Contra Costa Units 6 and 7 discharge canal, no evidence was found that suggested either behavioral avoidance or adverse effects as a direct consequence of exposure to the discharge from either power plant.

B-4.1 Thermal Plume Evaluations prior to 1982

Extensive field studies were conducted during 1971/1972 (PG&E 1973a, b) to evaluate potential effects associated with the discharges from the Pittsburg and Contra Costa power plants on

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aquatic organisms inhabiting the receiving waters. These investigations included discharge plume monitoring and biological surveys. No significant adverse effects were identified during these investigations.

During the mid-1970s evaluations of the potential adverse effects associated with discharges from the Pittsburg and Contra Costa power plants (TetraTech 1976a, b) were again conducted. These studies provided additional information on the characteristics of the power plant discharge plumes. Results of discharge monitoring were used in combination with biological survey data to develop a model to evaluate the potential adverse effects of the power plant discharge plumes on striped bass and other aquatic resources. Results of these investigations did not identify significant adverse environmental effects on striped bass and other aquatic resources as a consequence of exposure to the discharge plumes. Based on results of these investigations, the Central Valley and San Francisco Bay Regional Water Quality Control Boards authorized exemptions for the two power plants from State Thermal Plan Standards.

B-4.2 Thermal Plume Investigations in 1991 and 1992

In 1990, the San Francisco and Central Valley Regional Water Quality Control Boards requested that the potential effects of discharges from the Contra Costa and Pittsburg power plants on aquatic resources inhabiting the lower San Joaquin River and Suisun Bay be re-examined. In response to the need for additional information, a study to assess the effects of water temperature on aquatic organisms inhabiting receiving waters for the thermal discharges of both power plants was performed. The 1-year investigation was conducted from July 1991 through June 1992. The study included 1) an intensive water temperature monitoring program at the power plant cooling water discharges and receiving waters, and 2) monthly fisheries surveys at locations within the discharge plumes and at reference locations outside of the area of discharge plume exposure. During routine monthly fisheries surveys conducted as part of this investigation, information was collected on the presence of other fish species including Delta smelt, longfin smelt, Sacramento splittail, and chinook salmon in the receiving waters of both power plants.

Fisheries surveys were conducted monthly within the thermal discharges of both power plants and at reference sites. A variety of active and passive sampling techniques was used. The primary objectives of the monthly fisheries surveys were to describe the fisheries community inhabiting the discharge areas and to compare those discharge communities to populations located away from the discharge sites (reference locations). The second objective of the study was to document behavioral responses such as attraction, avoidance, and migration blockage created by the thermal component of the discharges. Measures to evaluate differences between discharge and reference populations included species abundance, species composition/diversity, size distribution, and fish condition. The health of fish within the discharge was compared to reference specimens by examining each individual for external parasites, disease, and deformities.

Active sampling gear used in this survey included bottom trawls, surface trawls, beach seines, and ichthyoplankton nets. Passive gears included gill nets and fyke nets. Electrofishing was also used to supplement standard monthly collection efforts. Sampling at Pittsburg Power Plant included three bottom trawl sampling stations, five surface trawl sampling stations, four gill net stations, four fyke net stations, two beach seine stations, two plankton stations, and five electrofishing stations. Sampling at Contra Costa Power Plant included four bottom trawl stations, four surface trawl stations, five gill net stations, four fyke net stations, two beach seine stations, two plankton stations, and four electrofishing stations. During each day's sampling effort, fish were collected during ebb and flood tidal conditions. Supplemental collections were also performed at night to assess potential diel variability.

A total of 1,674 fish representing 28 species and 16 families were collected in the vicinity of Pittsburg Power Plant during standard monthly collections between July 1991 and June 1992. A total of 3,769 fish representing 33 species and 16 families were collected during standard monthly fisheries surveys conducted in the vicinity of the Contra Costa Power Plant.

B-4.2.1 Delta Smelt. Delta smelt were collected in low numbers at the Contra Costa (25 fish) and the Pittsburg (21 fish) discharge and reference sites. The smelt were collected primarily in surface trawls, but they were also present in bottom trawls, fyke nets, and beach seines. At Contra Costa, the smelt were found between November and March and from July through August; at Pittsburg, the smelt were found between November and March and from July through September. In the plankton tows, Delta smelt were only collected in April surface tows, with larval delta smelt being collected at the Contra Costa discharge and reference sites and at the Pittsburg reference site.

B-4.2.2 Longfin Smelt. Longfin smelt were collected in low numbers at the Contra Costa sites (2 fish) and at the Pittsburg sites (7 fish). No longfin were collected at discharge sampling locations for either facility. However, longfin smelt were collected in bottom and surface trawls at the Contra Costa and Pittsburg sites. Longfin smelt were found at Contra Costa only in December and at Pittsburg in November (1 fish), December (4 fish), February (1 fish), and April (1 fish). Larval longfin smelt were present in plankton collections between December and March at Contra Costa and in November and March at Pittsburg. Larval longfin smelt were present in surface and bottom plankton samples from the Contra Costa discharge and reference sites during both ebb and flood tides. Larval longfin smelt were also collected from the Pittsburg discharge and reference sites (surface samples) during ebb and flood tides.

B-4.2.3 Sacramento Splittail. Sacramento splittail were collected at discharge and reference locations at both power plants. Splittail were present during each month at both facilities, representing 4% (147 fish) of the fish collected at the Contra Costa sites and 12% (193 fish) at the Pittsburg sites. Juvenile and adult Sacramento splittail were collected, and all the specimens were generally in good condition, showing few signs of distress. Splittail were caught primarily in beach seines and bottom trawls, but were also present in surface trawls, fyke nets, gill nets, and during electrofishing. No larval splittail were collected in plankton surveys at either power plant.

B-4.2.4 Chinook Salmon. Chinook salmon were collected at the discharge and reference locations at both power plants. Most of the chinook salmon were smolts collected in February, March, and April. Using length categories provided in PG&E's 1995 MOU with the CDFG, smolts collected during the surveys were divided into the following groups: fall/late fall-run - 84% (145 fish), spring-run - 14% (25 fish), and winter-run - 2% (3 fish). Chinook smolts were caught primarily in the surface trawls and by electrofishing. A few adult fish were caught in gill nets, with 6 adults at Pittsburg and 1 adult at Contra Costa. The adults were caught in August, September, and October.

B-4.2.5 Green Sturgeon. A single green sturgeon was collected during the 1-year survey. This specimen was a subadult at 382 mm in length and was collected at one of the Contra Costa reference stations.

Data are not available from either laboratory or field investigations for use in predicting the behavioral response of Delta smelt, longfin smelt, or Sacramento splittail to various elevated water temperatures occurring within the Contra Costa and Pittsburg power plant discharges. Delta smelt and Sacramento splittail were collected in areas within the influence of the power plant discharges and at reference locations; however, the numbers of fish collected were insufficient to effectively determine behavioral avoidance or attraction patterns for these species. Longfin smelt were collected in fewer numbers than either Delta smelt or splittail. Additional information on the actual numbers of each taxa collected, sampling locations, and collection methods has been documented in PG&E (1992).

Results of the 1991/1992 Thermal Effects Assessment showed that the discharge plume from the Contra Costa Power Plant had a surface area (2°F isotherm) ranging from approximately 5.4 to 45.5 acres. The surface area of the discharge plume at the Pittsburg Power Plant ranged from approximately 7.8 to 90.5 acres. The discharge plumes from both power plants remained close to the shoreline, and the direction and extent of the discharge plume were influenced primarily by tides. Discharge plumes from both power plants were located predominantly in the upper portion of the water column in a thin lens near the water surface.

Results of the fisheries investigations completed to date have demonstrated that the receiving waters for both power plants support diverse fish communities. Survey results provided no evidence of direct mortality to either juvenile or adult fish as a consequence of exposure to the discharge plume from either power plant. Fish were collected in good condition in the vicinity of the Pittsburg and Contra Costa power plants. Delta smelt and Sacramento splittail were collected at the Pittsburg and Contra Costa discharge and reference sites, and a comparison of the results did not show a pattern of attraction or avoidance. However, the numbers of fish collected were too low to allow meaningful statistical analysis. The areal extent of the discharge plumes, the rapid decline in water temperatures due to thermal dissipation and turbulent mixing, and strong tidal currents help to mix the thermal component of the discharge with the ambient receiving waters. Species that may be exposed to water temperatures outside of their preferred range are not trapped by the discharge plume; the fish can easily avoid areas that are too warm by moving offshore or by dropping down in the water column. Based on results of extensive thermal plume monitoring and biological studies, it was concluded that, other than the area within the Contra Costa Units 6 and 7 discharge canal, avoidance or exclusion from available habitat, adverse effects on health and condition, and other potentially adverse effects on various fish species, including the sensitive species addressed in this plan, inhabiting the receiving waters are not anticipated.

In reviewing results of the 1991/1992 Thermal Effects Assessment, the CDFG, USFWS, NMFS, and the Central Valley and San Francisco Bay Regional Water Quality Control Boards concluded that there was no evidence of adverse effects from exposure of local fish populations (those of the lower San Joaquin River and Suisun Bay) to discharges from the Pittsburg and Contra Costa power plants. No additional monitoring or management actions were required based on results of the Thermal Effects Assessment program.

B-4.3 Entrainment Survival

The previous discussion on thermal effects addresses the impact of heated discharge water on fish populations using the rece: .g waters, and does nc ddress the relationship between through-plant loss of entrained fish and exposure to elevated temperatures within the cooling water system. This question is addressed in the section on entrainment impacts.

Studies performed on larval striped bass, mysid shrimp, and other organisms (PG&E 1981a, b) have shown that entrainment survival is relatively high when cooling water discharge temperatures are less than 86°F. A substantial reduction in the frequency of discharge temperatures exceeding 86°F at the two power plants during the Striped Bass Entrainment Monitoring Program has contributed to a substantial increase in the survival of striped bass and other species of larval fish and macroinvertebrates. However, no species-specific data is available on the relationship between entrainment survival and discharge temperature for the species addressed in this plan, therefore, for the purposes of this plan it is assumed that no entrained fish survive.

APPENDIX C. RESULTS OF FLORISTIC SURVEYS OF MONTEZUMA ENHANCEMENT SITE

FAMILY	SPECIES	COMMON NAME	OBSERVED 1973-74[2]	OBSERVED 1977-78[3]
Alismataceae	*Alisma plantago-aquatica*	Broad-leaf Water-Plantain		X
Anacardiaceae	*Schinus molle*[4]	Peruvian Pepper Tree	X	X
	Toxicodenron diversilobum	Western Poison Oak	X	X
Apiaceae	*Conium maculatum*	Poison Hemlock		X
	Foeniculum vulgare	Fennel	X	X
	Hydrocotlye verticillata	Whorled Penny-wort	X	
Apocynaceae	*Apocynum cannabinum*	Clasping-leaf Dogbane	X	X
Asclepiadaceae	*Asclepias fascicularis*	Narrow-leaf Milkweed		X
	Asclepias eriocarpa	Indian Milkweed	X	
Asteraceae	*Achillea millefolium*	Common Yarrow		X
	Ambrosia psilostachya	Naked-spike Ragweed	X	X
	Anthemis cotula	Mayweed	X	X
	Artemisia douglasiana	Douglas' Wormwood		X
	Aster lentus	Suisun Aster		X
	Aster subulatus var. *ligulatus*	Slim Aster		X
	Baccharis douglasii	Douglas' False-willow		X
	Baccharis pilularis	Coyote Bush	X	X
	Baccharis salicifolia	Mulefat	X	X
	Centaurea solstitialis	Yellow Star-thistle	X	X
	Chamomilla suaveolens	Pineapple weed	X	
	Cirsium vulgare	Bull Thistle	X	X
	Conyza bonariensis	South American Conyza		X
	Cotula coronopifolia	Brass-buttons		X
	Euthamia occidentalis	Western Fragrant-golden-rod		X
	Gnaphalium stramineum	Cotton-batting Cudweed	X	X
	Gnaphalium luteo-album	Weedy Cudweed		X
	Grindelia camporum	Great Valley Gumweed		X
	Helenium bigelovii	Bigelow's Sneezeweed		X
	Helenium puberulum	Rosilla	X	
	Hemizonia lobbii	Tarweed	X	X
	Hemizonia pungens ssp. *maritima*	Common Spikeweed		X

FAMILY	SPECIES	COMMON NAME	OBSERVED 1973-74[2]	OBSERVED 1977-78[3]
	Heterotheca grandiflora	Telegraph Weed	X	X
	Hypochaeris glabra	Smooth Cat's-ear		X
	Isocoma menziesii var. *vernonoides*	Coastal Isocoma	X	
	Lactuca serriola	Prickly lettuce	X	X
	Lasthenia glabrata	Yellow-ray Goldfields	X	X
	Monolopia major	Cupped Monolopia	X	X
	Picris echioides	Bristly Ox-tongue	X	X
	Senecio vulgaris	Common Groundsel	X	X
	Silybum marianum	Milk Thistle	X	X
	Sonchus asper ssp. *asper*	Prickly Sow Thistle		X
	Sonchus oleraceus	Common Sow Thistle		X
	Tragopogon porrifolius	Salsify	X	X
	Xanthium strumarium	Rough Cocklebur	X	X
Azollaceae	*Azolla filiculoides*	Mosquito Fern		X
Betulaceae	*Alnus rhombifolia*	White Alder	X	X
Boraginaceae	*Amsinkia lycopsoides*	Bugloss Fiddle-neck	X	X
	Amsinkia menziesii	Rancher's Fireweed	X	X
	Heliotropium curassavicum	Heliotrope	X	X
Brassicaceae	*Brassica juncea*	Indian Mustard	X	
	Brassica nigra	Black Mustard	X	
	Hirschfeldia incana	Mediterranean Mustard		X
	Lepidium latifolium	Broad-leaf Peppergrass		X
	Lepidium nitidum	Shining Peppergrass		X
	Raphanus sativus	Radish		X
	Sisymbrium officinale	Hedge Mustard		X
Caprifoliaceae	*Lonicera involucrata*	Four-line Honeysuckle	X	X
Caryophyllaceae	*Silene gallica*	Common Catchfly	X	X
	Stellaria pallida	Common Chickweed	X	X
Chenopodiaceae	*Atriplex triang[illegible]s*	Spearscale		X
	Atriplex semibaccata	Australian saltbush	X	X
	Chenopodium ambrosioides	American Wormseed		X
	Chenopodium macrospermum var. *halophilum*	Coast Goosefoot		X
	Salicornia subterminalis	Common Glasswort	X	
	Salicornia virginica	Pickleweed	X	X

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FAMILY	SPECIES	COMMON NAME	OBSERVED 1973-74[2]	OBSERVED 1977-78[3]
	Salsola tragus	Tumbleweed	X	X
Convolvulaceae	*Calystegia sepium* ssp. *limnophila*	Hedge bindweed	X	X
	Convolvulus arvensis	Bindweed	X	X
	Cressa truxillensis	Alkali Weed	X	
Cucurbitaceae	*Marah fabaceus*	California Man-root	X	X
Cyperaceae	*Carex barbarae*	Santa Barbara Sedge		X
	Cyperus eragrostis	Tall Flatsedge		X
	Scirpus acutus var. *occidentalis*	Tule	X	X
	Scirpus californicus	California Bulrush		X
	Scirpus americanus	Olney's Bulrush	X	X
	Scirpus robustus	Alkali Bulrush	X	X
Dipsacaceae	*Dipsacus fullonum*	Wild Teasel	X	
Equisetaceae	*Equisetum arvense*	Common Horsetail	X	X
	Equisetum hymale ssp. *affine*	Common Scouring Rush		X
	Equisetum laevigatum	Smooth Scouring Rush	X	
Euphorbiaceae	*Eremocarpus setigerus*	Dove Weed	X	X
Fabaceae	*Hoita macrostachya*	Leather Root	X	X
	Lathyrus jepsonii var. *jepsonii*	Delta Tule Pea	X	X
	Lotus corniculatus	Birds-foot Trefoil	X	X
	Lotus purshianus var. *purshianus*	Spanish Clover		X
	Lotus scoparius	California Broom		X
	Lupinus succulentus	Arroyo Lupine		X
	Medicago polymorpha	California Burclover	X	X
	Melilotus alba	White sweetclover	X	X
	Melilotus indica	Sourclover		X
	Trifolium gracilentum	Pin-point Clover	X	
	Trifolium repens	White Clover	X	
Fabaceae	*Trifolium willdenovii*	Tomcat Clover	X	X
	Trifolium wormskioldii	Cow Clover		X
Frankeniaceae	*Frankenia salina*	Alkali Heath	X	X
Gentianaceae	*Centaurium muehlenbergii*	Monterey Centaury	X	X
Geraniaceae	*Erodium botrys*	Long-beaked filaree	X	X
	Erodium cicutarium	Red-stemmed Filaree	X	X
	Erodium moschatum	White-stemmed Filaree	X	X

FAMILY	SPECIES	COMMON NAME	OBSERVED 1973-74[2]	OBSERVED 1977-78[3]
Juglandaceae	*Juglans californica* var. *hindsii*	California Black Walnut	X	X
Juncaceae	*Juncus balticus*	Baltic Rush		X
	Juncus phaeocephalus var. *paniculatus*	Brown-headed Rush		X
Lamiaceae	*Lycopus americanus*	American Bugleweed		X
	Marrubium vulgare	Common Horehound		X
	Mentha piperita	Peppermint		X
	Stachys albens	White-stem Hedgenettle		X
Liliaceae	*Asparagus officinalis* ssp. *officinalis*	Garden Asparagus	X	X
	Dichelostemma capitatum	Blue Dicks		X
	Triteleia laxa	Ithuriel's Spear		X
Lythraceae	*Lythrum californicum*	California Loosestrife	X	X
	Lythrum hyssopifolium	Hyssop Loosestrife		X
Malvaceae	*Malva parviflora*	Cheeseweed	X	
Moraceae	*Ficus carica*	Fig		X
Oleaceae	*Fraxinus latifolia*	Oregon Ash	X	X
Onagraceae	*Camissonia micrantha*	Small Primrose	X	X
	Epilobium brachycarpum	Panicled Willow Herb	X	X
	Epilobium ciliatum ssp. *ciliatum*	California Willow Herb		X
Papaveraceae	*Eschscholzia californica*	California Poppy		X
Plantaginaceae	*Plantago subnuda*	Mexican Plantain	X	X
	Plantago lanceolata	English Plantain	X	
Poaceae	*Agrostis viridus*	Water Bent Grass	X	X
	Arundo donax	Giant Reed		X
	Avena barbata	Slender Wild Oat		
	Avena fatua	Wild Oat	X	
	Bromus diandrus	Ripgut Grass	X	X
	Bromus hordeaceus	Soft Brome	X	X
	Bromus japonicus	Japanese Brome	X	
	Bromus madritensis ssp. *rubens*	Foxtail Chess	X	X
	Crypsis schoenoides	Swamp Timothy	X	
	Cynodon dactylon	Bermuda Grass	X	X
	Deschampsia cespitosa ssp. *holciformis*	Tufted Hair Grass		X
	Distichlis spicata	Saltgrass	X	X

FAMILY	SPECIES	COMMON NAME	OBSERVED 1973-74[2]	OBSERVED 1977-78[3]
	Echinochloa crus-galli	Barnyard Grass		X
	Elymus stebbensii	Wheatgrass	X	
	Hordeum jubatum	Foxtail Barley	X	X
	Hordeum marinum ssp. *glaucum*	Foxtail Barley	X	
	Hordeum marinum ssp. *gussoneanum*	Mediterranean Barley		X
	Hordeum murinum ssp. *leporinum*	Farmer's Foxtail		X
Poaceae	*Koeleria phleoides*	Bristly koeleria	X	
	Leymus triticoides	Creeping Wild-rye		X
	Lolium multiflorum	Italian Ryegrass	X	X
	Paspalum dilatatum	Dallis Grass	X	X
	Phragmites australis	Common Reed	X	X
	Poa annua	Annual Bluegrass	X	X
	Polypogon monspeliensis	Annual Rabbit-foot Grass		X
	Setaria gracilis	Knotroot Bristle Grass		X
	Vulpia bromoides	Six-weeks Fescue	X	X
	Vulpia myuros var. *hirsuta*	Rattail Fescue	X	X
Polygonaceae	*Polygonum arenastrum*	Common Knotweed	X	X
	Polygonum punctatum	Water Smartweed	X	X
	Rumex conglomeratus	Green Dock		X
	Rumex crispus	Curly Dock	X	X
Portulacaceae	*Calandrinia ciliata*	Red Maids		X
	Claytonia perfoliata	Miner's Lettuce		X
	Claytonia exigua ssp. *exigua*	Common Claytonia		X
Potamogetonaceae	*Ruppia maritima*	Widgeon-grass		X
Primulaceae	*Centunculus minimus*	Chaffweed		X
Rosaceae	*Malus sylvestris*	Apple	X	
	Prunus dulcis	Almond	X	
	Rosa californica	California Rose	X	X
	Rubus discolor	Himalayan Blackberry		X
	Rubus ursinus	California Blackberry	X	
Rubiaceae	*Cephalanthus occidentalis* var. *californicus*	California Button-willow	X	X
Salicaceae	*Populus fremontii* ssp. *fremontii*	Fremont Cottonwood	X	X
	Salix goodingii	Gooding's Black Willow	X	X

FAMILY	SPECIES	COMMON NAME	OBSERVED 1973-74 [2]	OBSERVED 1977-78 [3]
	Salix exigua	Narrow-leaved Willow	X	X
	Salix laevigata	Red Willow	X	X
	Salix lucida spp. *lasiandra*	Shining Willow		X
	Salix lasiolepis	Arroyo Willow	X	X
Scrophulariaceae	*Castilleja exserta*	Purple Owl's Clover		X
	Mimulus guttatus	Common Monkeyflower	X	X
Solanaceae	*Solanum americanum*	Small-flowered Nightshade	X	X
Tamaricaceae	*Tamarix parviflora*	Tamarisk	X	
Typhaceae	*Typha angustifolia*	Narrow-leaved cattail	X	X
	Typha domingensis	Southern Cattail		X
	Typha latifolia	Broad-leaved Cattail		X
Urticaceae	*Urtica urens*	Dwarf Nettle		X

[1] Nomenclature follows Hickman (1993)
[2] Based on floristic surveys conducted by Jones & Stokes Associates, Inc (1975)
[3] Based on floristic surveys conducted by BioSystems Analysis, Inc. (1980)
[4] Shaded entries are non-native species

APPENDIX D. RESULTS OF WILDLIFE SURVEYS OF MONTEZUMA ENHANCEMENT SITE

COMMON NAME	SPECIES	OBSERVED 1973-74 [1]	OBSERVED 1975-1978 [2]	OBSERVED 1994
AMPHIBIANS AND REPTILES				
Western Toad	*Bufo boreas*		X	
Pacific Treefrog	*Hyla regilla*	X	X	
Bullfrog	*Rana catesbiana*		X	
Northwestern Pond Turtle	*Clemmys marmota marmota*	X	X	
Southern Alligator Lizard	*Gerrhonotus multicarinatus*	X	X	
Western Fence Lizard	*Sceloperus occidentalis*	X		
Rubber Boa	*Charina bottae*	X		
Racer	*Coluber constrictor*		X	
Gopher Snake	*Pituophis melanoleucus*	X	X	
Common Garter Snake	*Thamnophis sirtalis*	X	X	
BIRDS				
Common Loon	*Gavia immer*	X		
Horned Grebe	*Podiceps auritius*	X		
Eared Grebe	*Podiceps nigricollis*	X		
Western Grebe	*Aechmorphorus occidentalis*	X		
Pied-billed Grebe	*Podilymbus podiceps*	X		X
American White Pelican	*Pelecanus erythrorhynchos*			
Double-crested Cormorant	*Phalacrocorax auritus*	X	X	X
Great Blue Heron	*Ardea herodias*	X	X	X
Great Egret	*Casmerodius albus*	X		X
Black-crowned Night-Heron	*Nycticorax nycticorax*	X		
American Bittern	*Botaurus lentiginosus*	X	X	
Tundra Swan	*Cygnus columbianus*		X	
Canada Goose	*Branta canadensis*	X	X	
Greater White-fronted Goose	*Anser albifrons*	X		
Snow Goose	*Chen caerulescens*	X		
Mallard	*Anas platyrhynchos*	X	X	X
Gadwall	*Anas strepera*	X		
Pintail	*Anas acuta*	X	X	
Green-winged Teal	*Anas crecca*	X	X	
Blue-winged Teal	*Anas discors*		X	
Cinnamon Teal	*Anas cyanoptera*	X	X	
American Widgeon	*Anas americana*	X		
Northern Shoveler	*Anas clypeata*	X	X	
Redhead	*Aythya americana*	X		
Ring-necked Duck	*Aythya collaris*	X		
Canvasback	*Aythya valisneria*	X		
Lesser Scaup	*Aythya affinis*	X		
Common Goldeneye	*Bucephala clangula*	X		
Ruddy Duck	*Oxyura jamaicensis*	X		
Turkey Vulture	*Cathartes aura*	X	X	X
Black-shouldered Kite	*Elanus caeruleus*	X	X	X
Sharp-shinned Hawk	*Accipiter striatus*	X		
Cooper's Hawk	*Accipiter cooperii*	X		
Red-tailed Hawk	*Buteo jamaicensis*	X	X	X
Red-shouldered Hawk	*Buteo lineatus*	X		
Swainson's Hawk	*Buteo swainsoni*	X		
Rough-legged Hawk	*Buteo lagopus*	X	X	

COMMON NAME	SPECIES	OBSERVED 1973-74 [1]	OBSERVED 1975-1978 [2]	OBSERVED 1994
Ferruginous Hawk	*Buteo regalis*	X		X
Golden Eagle	*Aquila chrysaetos*	X	X	
Northern Harrier	*Circus cyaneus*	X	X	X
Prairie Falcon	*Falco mexicanus*	X	X	X
American Kestrel	*Falco sparverius*	X	X	X
California Quail	*Callipepla californica*	X	X	
Ring-necked Pheasant	*Phasianus colchicus*	X	X	X
Virginia Rail	*Rallus limicola*	X	X	
Sora	*Porzana carolina*	X	X	
Common Moorhen	*Gallinula chloropus*	X		X
American Coot	*Fulica americana*	X	X	X
Killdeer	*Charadrius vociferus*	X	X	
Common Snipe	*Gallinago gallinago*	X		
Long-billed Curlew	*Numenius americanus*	X	X	
Spotted Sandpiper	*Actitis macularia*	X		
Greater Yellowlegs	*Tringa melanoleuca*	X		
Lesser Yellowlegs	*Tringa flavipes*		X	
Least Sandpiper	*Caldris minutilla*	X	X	
American Avocet	*Recurvirostra americana*	X		
Black-necked Stilt	*Himantopus mexicanus*	X	X	
Glaucous Gull	*Larus hyperboreus*	X		
Herring Gull	*Laurus argentatus*	X	X	
California Gull	*Larus californicus*	X	X	X
Ring-billed Gull	*Larus delawarensis*	X		
Forster's Tern	*Sterna forsteri*		X	
Caspian Tern	*Sterna caspia*	X		
Rock Dove	*Columba livia*	X		X
Mourning Dove	*Zenaida macroura*	X	X	X
Common Barn Owl	*Tyto alba*	X	X	
Short-eared Owl	*Asio flammeus*	X		
Great Horned Owl	*Bubo virginianus*	X		X
Burrowing Owl	*Athene cunicularia*	X	X	
Anna's Hummingbird	*Calypte anna*	X	X	
Rufous Hummingbird	*Selasphorus rufus*	X		
Belted Kingfisher	*Ceryle alcyon*			X
Northern Flicker	*Colaptes auratus*		X	X
Acorn Woodpecker	*Melanerpes formicivorus*	X		
Red-breasted Sapsucker	*Sphyrapicus ruber*	X		
Downy Woodpecker	*Picoides pubescens*	X	X	
Lewis' Woodpecker	*Melanerpes lewis*	X		
Western Kingbird	*Tyrannus verticalis*	X	X	
Ash-throated Flycatcher	*Myiarchus cinerascens*	X		
Black Phoebe	*Sayornis nigricans*	X		X
Say's Phoebe	*Sayornis saya*	X	X	
Willow Flycatcher	*Empidonx traillii*	X		
Western Wood Pewee	*Contopus sordidulus*	X		
Horned Lark	*Eremophila alpestris*	X	X	
Violet-green Swallow	*Tachycinetta thalassina*	X	X	
Tree Swallow	*Tachycinetta bicolor*	X		
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*		X	
Barn Swallow	*Hirundo rustica*	X	X	
Scrub Jay	*Aphelocoma coerulescens*	X		
Common Raven	*Corvus corax*	X		
Common Crow	*Corvus brachyrynchos*	X	X	

Bushtit	*Psaltriparus minimus*	X	X	
House Wren	*Troglodytes aedon*	X	X	

COMMON NAME	SPECIES	OBSERVED 1973-74 [1]	OBSERVED 1975-1978 [2]	OBSERVE D 1994
BIRDS				
Bewick's Wren	*Thryomanes bewickii*		X	
Marsh Wren	*Cistothorus palustris*	X	X	X
Northern Mockingbird	*Mimus polyglottos*	X	X	X
American Robin	*Turdus migratorius*	X	X	X
Hermit Thrush	*Catharus guttatus*	X		
Blue-gray Gnatcatcher	*Polioptila caerulea*	X		
Golden-crowned Kinglet	*Regulus satrapa*	X		
Ruby-crowned Kinglet	*Regulus calendula*	X	X	
Water Pipit	*Anthus spinoletta*	X	X	
Loggerhead Shrike	*Lanius ludovicianus*	X	X	X
European Starling	*Sturnus vulgaris*	X	X	X
Solitary Vireo	*Vireo solitarius*	X		
Orange-crowned Warbler	*Vermivora celata*		X	
Yellow-rumped Warbler	*Dendroica coronata*	X	X	
Yellow Warbler	*Dendroica petechia*	X		
Townsend's Warbler	*Dendroica townsendi*	X		
Black-throated Gray Warbler	*Dendroica nigrescens*		X	
MacGillivray's Warbler	*Oporornis tolmiei*	X		
Common Yellowthroat	*Geothlypis trichas*	X	X	
Wilson's Warbler	*Wilsonia pusilla*	X	X	
House Sparrow	*Passer domesticus*	X	X	
Western Meadowlark	*Sturnella neglecta*	X	X	X
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	X		
Red-winged Blackbird	*Agelaius phoeniceus*	X	X	X
Tricolored Blackbird	*Agelaius tricolor*		X	
Brewer's Blackbird	*Euphagus cyanocephalus*	X	X	X
Brown-headed Cowbird	*Molothrus ater*	X		
Western Tanager	*Piranga ludoviciana*	X		
Black-headed Grosbeak	*Pheuticus melanocephalus*		X	
Purple Finch	*Carpodacus purpureus*		X	
House Finch	*Carpodacus mexicanus*	X	X	X
American Goldfinch	*Carduelis tristis*	X	X	
Lesser Goldfinch	*Carduelis psaltria*	X	X	
Rufous-sided Towhee	*Pipilo erythrophthalmus*	X	X	
Brown Towhee	*Pipilo fuscus*	X	X	X
Savannah Sparrow	*Passerculus sandwichensis*	X	X	X
Lark Sparrow	*Chondestes grammacus*	X		
Dark-eyed Junco	*Junco hyemalis*	X	X	X
Grasshopper Sparrow	*Ammodramus savannarum*		X	
White-crowned Sparrow	*Zonotrichia leucophrys*	X	X	
Golden-crowned Sparrow	*Zonotrichia atricapilla*	X	X	
White-throated Sparrow	*Zonotrichia albicollis*	X		
Fox Sparrow	*Passerella iliaca*	X		
Lincoln's Sparrow	*Melospiza lincolnii*		X	
Song Sparrow	*Melospiza melodia*	X	X	
Suisun Song Sparrow	*Melospiza melodia maxillaris*		X	
MAMMALS				
Common Opossum	*Didelphis marsupialis*		X	X
Black-tailed Hare	*Lepus californicus*	X	X	X
Audubon Cottontail	*Sylvilagus audubonii*	X	X	X
Beechy Ground Squirrel	*Spermophilus beecheyi*	X	X	X
Botta Pocket Gopher	*Thomomys bottae*	X	X	
Beaver	*Castor canadensis*		X	

COMMON NAME	SPECIES	OBSERVED 1973-74 [1]	OBSERVED 1975-1978 [2]	OBSERVED 1994
MAMMALS				
Western Harvest Mouse	*Reithrodontomys megalotis*	X	X	X
Salt Marsh Harvest Mouse	*Reithrodontomys raviventris*		X	
Deer Mouse	*Peromyscus maniculatus*	X	X	
California Meadow Mouse	*Microtus californicus*	X	X	
Muskrat	*Ondrata zibethica*	X	X	
Norway Rat	*Rattus norvegicus*	X		
Black Rat	*Rattus rattus*		X	
House Mouse	*Mus musculus*	X	X	X
Coyote	*Canis latrans*	X	X	X
Red Fox	*Vulpes fulva*		X	X
Gray Fox	*Urocyon cinereoargentus*	X	X	
Raccoon	*Procyon lotor*	X	X	X
Long-tailed Weasel	*Mustela frenata*	X		
River Otter	*Lutra canadensis*	X		X
Badger	*Taxidea taxus*		X	
Spotted Skunk	*Spilogale putorius*	X		
Striped Skunk	*Mephitis mephitis*	X	X	
Bobcat	*Lynx rufus*		X	
Black-tailed Deer	*Odocoileus hemionus*		X	

[1] Based on surveys conducted by Jones & Stokes Associates, Inc. (1975)
[2] Based on surveys conducted by BioSystems Analysis, Inc. (1980) and Ficket (1976)

APPENDIX E. CIRCULATING WATER PUMP VARIABLE SPEED DRIVE (VSD) OPERATION

The circulating water pumps at Delta Power Plants are mixed flow vertical centrifugal pumps equipped with A-C induction motor drives. The drives have been modified to utilize variable speed drive (VSD) controls, as well as to operate at full rated speed. The VSD controls provide a means to vary drive speed by varying frequency. For a centrifugal pump, flow is proportional to pump speed. Therefore as frequency and drive/pump speed are reduced, pump flow is also reduced proportionally (i.e., 50% pump speed => 50% pump flow).

When operating in VSD mode, the circulating water pump speed/flow is typically at its minimum level when the unit is at minimum load. For Pittsburg Power Plant Units 1-4, minimum load is ~30 - 35 megawatts (MW) and minimum pump speed/flow is 70% of design. The minimum circulating water pump speed/flow is limited by both the pump & motor design and the system head requirements. For Pittsburg Power Plant Units 5 & 6 and Contra Costa Power Plant Units 6 & 7 minimum flow is 50% of design and minimum load is ~25 - 45 MW. As unit load increases, pump speed and flow are increased in accordance with unit conditions. Maximum circulating water speed/flow, 95 - 100% of design, is typically reached at ~45 - 60 MW for Pittsburg Power Plant Units 1-4 and at ~90 - 145 MW for Pittsburg Power Plant Units 5 & 6 and Contra Costa Power Plant Units 6 & 7. River water temperature, tide, condenser vacuum, steam flow, etc., all have an effect on circulating water flow requirements. The controls may include overrides and/or trips off VSD, for unit/equipment protection.

During February 1 through July 31, the circulating water pumps on Pittsburg Power Plant Units 1-6 & Contra Costa Power Plant Units 6 & 7 will be operated in VSD mode when the units are operating under the following conditions:

- Minimum load
- Manual (operator controlled) loading up to 50% of rated capacity
- Low Range Automatic (remote) Generation Control (AGC)

The circulating water pumps will be operated in bypass mode when flow reductions are not achievable, when the units are operated under the following conditions:

- Full load
- Manual loading above 50%
- High Range AGC

The current operating ranges for Low Range and High Range AGC are below:

	Low Range AGC	High Range AGC
CCPP Units 6 & 7	60 - 180 MW	130 - 325 MW
PPP Units 1-4	28 - 78 MW	78 - 150 MW
PPP Units 5 & 6	60 - 160 MW	135 - 300 MW

These operating conditions were modeled using past operational data to evaluate potential flow reductions achievable by running circulating water pumps in VSD mode. Table E-1 shows the potential flow differences between use of VSDs versus actual operational flows for selected years between 1990 and 1997 for Contra Costa and Pittsburg Power Plants. Table E-2 provides data showing the percentage of total actual circulating water pump design flow for the years 1987-1997 for Contra Costa and Pittsburg Power Plants. Figure E-1 graphically illustrates the occurrence of desgn flows for the Contra Costa and Pittsburg Power Plants for the months of February–July for 1986–1999.

Table E-1

Flow[1] Difference between modeled use of VSD's and Actual Operation (non-VSD) by Month[2] for Selected Years

(Highlighted cells indicate months when VSD operation resulted in flow reductions which would not have been required under a simple flow maximum.)

Contra Costa Power Plant Units 6 & 7

Month/Operational Mode		Year					
		1990	1991	1993	1994	1995	1997
February	Actual Flow[2]	98	96	99	91	30	51
	Calc. VSD Flow	84	86	92	87	26	41
	Difference	14	10	7	4	4	10
March	Actual Flow	55	99	99	88	25	45
	Calc. VSD Flow	45	94	88	83	21	38
	Difference	10	5	11	5	4	7
April	Actual Flow	43	77	74	97	12	44
	Calc. VSD Flow	38	64	58	93	10	38
	Difference	5	13	16	4	2	6

Pittsburg Power Plant Units 1 -7

Month/Operational Mode		Year					
		1990	1991	1993	1994	1995	1997
February	Actual Flow[2]	79	80	76	64	28	20
	Calc. VSD Flow	72	70	67	60	20	15
	Difference	7	10	9	4	8	5
March	Actual Flow	82	84	61	58	25	26
	Calc. VSD Flow	71	74	53	52	20	20
	Difference	11	10	8	6	5	6
April	Actual Flow	86	91	50	80	21	34
	Calc. VSD Flow	81	76	37	77	18	27
	Difference	5	15	13	3	3	7

[1] Percent of design flow

[2] Only Feb. through April are shown because May through July flows are already reduced through use of VSD's as required under the Resources Management Program to reduce losses of striped bass due to entrainment.

Table E-2

Contra Costa Power Plant Units 6 & 7
Monthly CW Flow, % of Design

Month	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	Average Flow
FEB	32	96	52	97	100	98	52	100	92	30	56	51	20	85	69
MAR	32	100	61	38	55	100	55	99	89	26	44	45	13	86	60
APR	49	61	79	38	43	78	79	75	97	12	16	44	44	99	58
MAY	50	78	94	49	42	44	30	17	11	0	23	46	20	17	37
JUN	55	73	95	35	52	43	63	31	23	11	38	43	28	20	44
JUL	61	99	100	71	73	64	84	63	96	38	69	60	70	57	72
Average	47	85	80	55	61	71	61	64	68	20	41	48	33	61	57

Pittsburg Power Plant Units 1- 7
Monthly CW Flow, % of Design

Month	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	Average Flow
FEB	53	79	61	89	79	80	60	76	64	28	26	20	11	34	54
MAR	52	68	97	85	82	84	79	61	58	25	22	26	21	36	57
APR	24	77	88	79	86	91	66	50	80	21	24	34	20	47	56
MAY	14	68	80	25	56	35	39	15	23	12	19	35	9	11	32
JUN	39	75	72	45	33	25	39	27	22	20	30	25	19	21	35
JUL	50	63	88	82	64	53	72	27	61	28	57	35	52	46	56
Average	39	72	81	68	67	61	59	43	51	22	30	29	22	33	48

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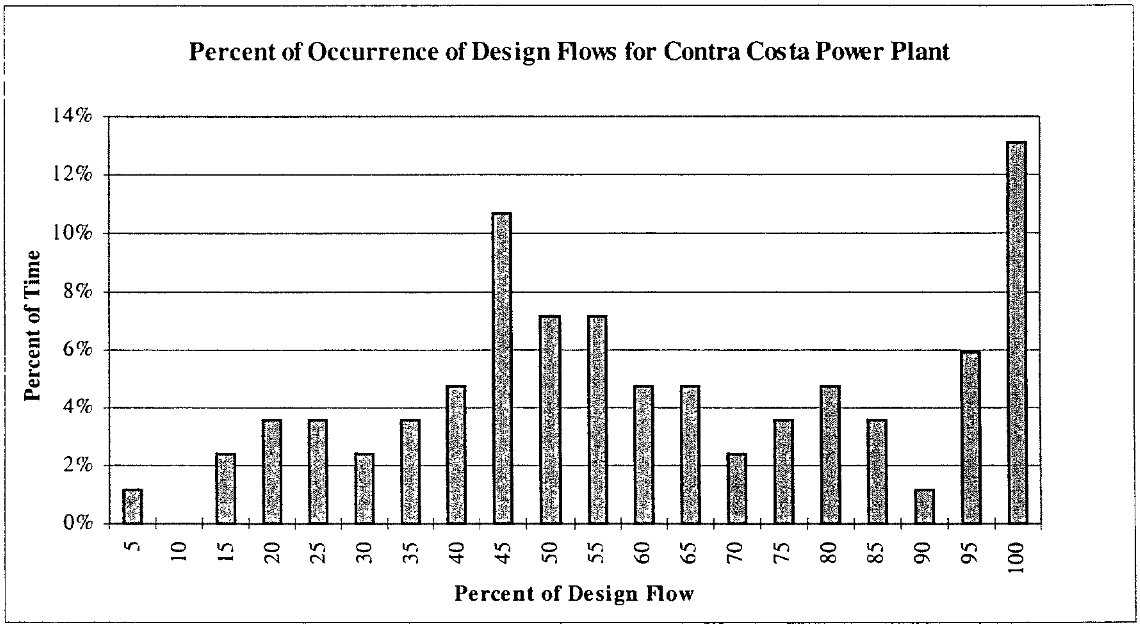
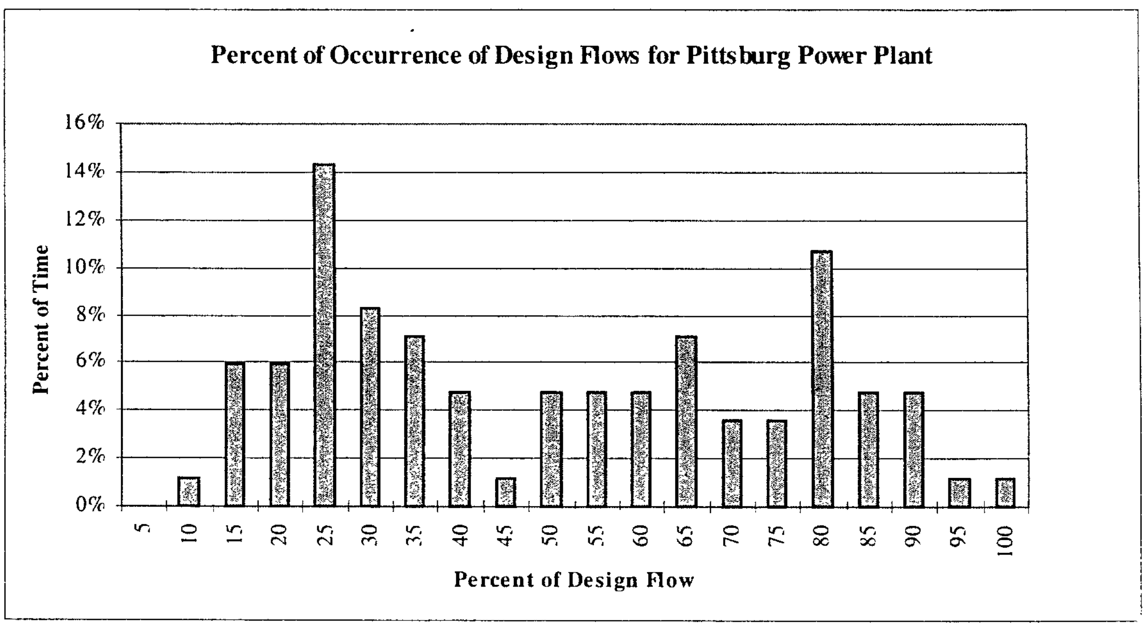
SKR:C/Data/Hcp/TabE-2



87% of the time flows were at, or below, 95% of monthly design flows (Units 6&7) at the Contra Costa Power Plant for February - July, 1986 - 1999



88% of the time flows were at, or below 80% of monthly design flows at the Pittsburg Power Plant for February - July, 1986 - 1999

Figure E-1. Percent of occurrence of design flows for the Contra Costa (upper figure) and Pittsburg (lower figure) power plants for the months of February - July for 1986-1999.

SKR:C/Data/Hcp/FigE-1

APPENDIX F. MITIGATION COMPENSATION PROGRAM

Power plant cooling water intake will be limited below the design capacity of the circulating water pumps through use of variable speed drive (VSD) controls on the circulating water pumps. Future system demands may on occasion require full power production and maximum cooling water system flow to meet system reliability needs. At such time the units would be required to run at full speed and variable speed drive would not be feasible and the cooling water intake threshold of 80% of design flow at the Pittsburg Power Plant Units 1-7 and 95% of design flow at the Contra Costa Power Plant Units 6 and 7 may be exceeded. The methods for determining required compensation mitigation for Delta smelt and winter-run chinook salmon are described below. Appropriate methods for other species in the HCP will be developed as needed. However, the total annual mitigation compensation amount will be limited to a maximum amount of $100,000 per power plant. The final annual mitigation amount will calculated, typically near November, after the fall mid-water trawl index for Delta smelt is released.

METHOD FOR ASSESSING COMPENSATION FOR DELTA SMELT

Compensation is determined based on four factors:

a. the degree to which the power plants exceed prescribed circulating water flow thresholds,
b. the amount of compensation per percentage points of exceedance,
c. the abundance of Delta smelt in the area of the power plants, and
d. the abundance of Delta smelt throughout the Delta.

a. Power Plant Operation in Excess of Prescribed Limits

The extent that a power plant exceeds its prescribed threshold flow in any one month was measured as the sum of the percentage points of exceedance of the 7-day running average operation. For example, if the 7-day running average exceeded the 95% threshold at the Contra Costa Power Plant by a total of 10% over 10 days (e.g. 1% per day) during a month then the percentage points of exceedance for the month would be 10. Full operation (100%) for a 30-day month would be 150 percentage points of exceedance (30 times 5).

b. Compensation Amount Based upon Level of Exceedance

Based on the 7-day running average of cooling water flow, the mitigation amounts per percentage point of exceedance were determined for each power plant for a maximum potential mitigation of $1,500 per day when cooling water flow is at design levels (100%). This resulted in $75 per percentage point of exceedance at Pittsburg Power Plant and $300 per percentage point of exceedance at Contra Costa Power Plant.

c. Abundance of Delta Smelt in the Area of the Power Plants

February through July occurrence of Delta smelt near the power plants is best measured from agency surveys in the Bay-Delta:

- Egg and Larvae Survey
- Summer Townet Survey
- Real-Time Monitoring Townet Survey
- 20-mm Townet Survey
- Beach Seine Survey (part of the Juvenile Migration Survey)
- Salmon Trawl Survey at Chipps Island (part of the Juvenile Migration Survey)
- Fall Mid-Water Trawl Survey

Of these surveys, only the first four provide adequate catches of Delta smelt in the February through July period of greatest susceptibility to the plants. Each of these four surveys provides an independent index of Delta smelt abundance near the plants and throughout Bay-Delta survey area. Each survey has a different survey design in terms of sampling locations and frequency. For this reason, an index of abundance of the population near the plants for a particular month is calculated for each survey by dividing the catch near the plant that month by the total survey catch for the season. This serves to incorporate the importance of the area near a power plant by month relative to the Bay-Delta population throughout the year. In short, each month's catch near a power plant is weighted by the total catch for the season.

Rather than provide four independent indices of abundance, the average of the four indices was used as the measure of risk at the respective power plant. For a two survey example, one survey caught 8 Delta smelt for a month near Pittsburg and the total catch for the entire survey (all sites and all months sampled) was 300 Delta smelt. A second survey caught 2 Delta smelt in the same month near Pittsburg and the total survey catch (all sites) for that year was 150 Delta smelt. For each survey, the proportion caught near Pittsburg is calculated by dividing the number caught near Pittsburg by the entire survey catch (8/300 and 2/150). The Pittsburg Delta smelt index would be the average of those two proportions (6/300).

The sites selected from each survey were those located within one tidal excursion of each plant. The tidal excursions were 10 miles and 8 miles at Pittsburg and Contra Costa, respectively. All survey locations upstream and downstream for those distances were included. Surveys that sampled at least part of the February through July period were included. Survey sites that had little or no sampling within the last 10 years were excluded. For each survey, all sites considered near a power plant (± tidal excursion distance) and not excluded due to limited sampling were added together (e.g., the summer townet survey had 6 sites near Pittsburg; for each month the catches at those 6 sites were added to give a total catch near Pittsburg). Near the Contra Costa Power Plant, the summer townet survey had 2 sites, the striped bass egg and larvae survey had 5 sites, the 20mm survey had 4 sites, and the real-time survey had 1 site (Table F-1). Near the Pittsburg Power Plant, the summer townet survey had 6 sites, the striped bass egg and larvae survey had 8 sites, the 20mm survey had 6 sites, and the real-time survey had 1 site (Table F-1).

Table F-1. Surveys and Survey Sites Used (or proposed to be used as data become available) in Determining Delta Smelt Abundance Near the Pittsburg and Contra Costa Power Plants

Survey	Local Survey Locations	
	Pittsburg Power Plant	**Contra Costa Power Plant**
Real-Time Monitoring Program [1]	Chipps Island	Jersey Point
20-mm Townet Survey [1]	504, 508, 513, 519, 520, 801	703, 802, 804, 809
Striped Bass Egg and Larvae Survey	9, 11, 13, 15, 17, 33, 35, 66	35, 37, 39, 41, 43
Summer Townet Survey	504, 508, 513, 519, 520, 801	804, 809

[1] Proposed: data not available in time to evaluate.

For the purposes of this simulation, only the egg and larval survey and the summer townet survey data were available. Data from the Real-Time Monitoring and 20-mm Townet Surveys were not available in time to include into our index calculations. These surveys would add to the index calculations, particularly because sampling is more frequent than the Egg and Larvae and Townet Surveys. In addition, as new surveys or new survey locations for the existing surveys become available, they will be evaluated for inclusion into the index calculation. If surveys or survey locations are discontinued, they will be removed from the index calculation. If no surveys are done, then comparable water year type survey results would be used as approved by the Department of Fish and Game and the U.S. Fish and Wildlife Service.

d. Annual Index of Delta Smelt

In addition to smelt abundance near the plant, compensation for exceeding prescribed operation limits would also consider the annual index of abundance of Delta smelt from the fall midwater trawl survey. If the annual production is low, then mitigation compensation would be greater, and visa-versa. A fall midwater trawl Delta smelt index of 235 was defined as a benchmark or critical population level. This le\ ،/as used in the Biolo_ .ل Opinion for the Delta Wetlands Project as a critical threshold for the population.

ESTIMATING COMPENSATION

Compensation for exceeding circulating water thresholds above predetermined threshold volumes is assessed based on four basic parameters:

a. The extent of operation above the prescribed limits as measured by the number of percentage points the 7-day running average is above the prescribed 80 and 95% circulating water thresholds.

b. The amount of compensation per percentage point of exceedance of the respective 80 and 95% thresholds, $75 for Pittsburg and $300 for Contra Costa per percentage point of exceedance.

c. Survey abundance of Delta smelt by month in the region of each of the power plants; up to four surveys types may be available in any single month. Each survey's abundance is divided by the total Bay-Delta seasonal abundance to factor in local abundance with total population abundance.

d. The annual index of Delta smelt production measured at the end of the season in the Fall Midwater Trawl Survey.

Compensation is assessed as follows:

a. A base level of mitigation is calculated based upon exceeding the cooling water flow threshold (80% of design flow at Pittsburg and 95% of design flow at Contra Costa). The base level mitigation also represents the theoretical maximum mitigation which is adjusted later to incorporate biological information. When the average flow has exceeded the threshold level, the percentage points of exceedance is calculated by subtracting the threshold percentage from the actual 7-day average flow percentage of design.

   Percentage points of exceedance = (7-day average flow/design flow) - 80% (Pittsburg),
   Percentage points of exceedance = (7-day average flow/design flow) - 95% (Contra Costa).

b. The base mitigation amount is the number of percentage points of exceedance the daily 7-day average is above threshold multiplied by $75 for Pittsburg or $300 for Contra Costa (Table . 2). Hence, only when the thresholds have been exceeded, is the daily base level of mitigation calculated as follows.

   Base mitigation = percentage points of exceedance * $75 per percentage point (Pittsburg),
   Base mitigation = percentage points of exceedance * $300 per percentage point (Contra Costa).

Table F-2. Daily Base Mitigation Amounts Based Upon the 7-Day Average Flow Exceeding Threshold Limits (For example, if the Pittsburg Power Plant 7-day average flow exceeded the 80% of design flow threshold for 9 days straight: 82%, 84%, 86%, 88%, 87%, 89%, 86%, 92%, and 90%, respectively. The 9 days would add up to 64 percentage points above the threshold, 2 + 4 + 6 + 8 + 7 + 9 + 6 + 12 + 10 = 64. The resulting mitigation amounts are $150 + $300 + $450 + $600 + $525 + $675 + $ 450 + $900 + $750 = $4,800.)

Pittsburg Power Plant	
Percentage Points above Threshold Level	**Mitigation**
1	$75
2	$150
3	$225
4	$300
5	$375
6	$450
7	$525
8	$600
9	$675
10	$750
11	$825
12	$900
13	$975
14	$1,050
15	$1,125
16	$1,200
17	$1,275
18	$1,350
19	$1,425
20	$1,500

Contra Costa Power Plant	
Percentage Points above Threshold Level	**Mitigation**
0.25	$75
0.50	$150
0.75	$225
1.00	$300
1.25	$375
1.50	$450
1.75	$525
2.00	$600
2.25	$675
2.50	$750
2.75	$825
3.00	$900
3.25	$975
3.50	$1,050
3.75	$1,125
4.00	$1,200
4.25	$1,275
4.50	$1,350
4.75	$1,425
5.00	$1,500

A mitigation adjustment is calculated at the end of the year for each month from the local abundance index and the fall midwater trawl Delta smelt index (Table F-3). The adjustment serves to incorporate the local and overall abundance of Delta smelt into the calculation of the mitigation amount. The adjustment is multiplied with the base mitigation to determine actual mitigation for each month at the end of the year,

actual mitigation = base mitigation * mitigation adjustment.

c. The local abundance index is the average survey local area catch divided by the survey's regional catch for the season. The local abundance index represents the fraction of the population that occurs near the power plants in a particular month. An index of 1 means, for the entire season, all surveys and survey sites, Delta smelt were caught only near the power plant and only in that particular month.

d. The fall midwater trawl Delta smelt index is calculated by CDFG and estimates overall Delta smelt abundance. When the fall midwater trawl Delta smelt index is less than or equal to 235 then the population is considered to be at risk and the mitigation adjustment is equal to the local abundance index. However, when the fall midwater trawl index is greater than 235 then the populations is considered to be not at high risk and the mitigation adjustment is one-half the local abundance index (Table F-3). For example, if the local abundance index was 1 and the fall midwater trawl index was low, then the mitigation adjustment would be 1 and the base mitigation would not be affected. However, if the fall midwater trawl index was high, then the mitigation adjustment would be half of the local abundance index and the base mitigation would be reduced by half.

Table F-3. Mitigation Adjustment Factor Based Upon Local and Regional CDFG Survey Data [1]

LOCAL ABUNDANCE INDEX	Mitigation Adjustment	
	Fall Midwater Trawl Delta Smelt Index ≤ 235	Fall Midwater Trawl Delta Smelt Index > 235
1	1	0.5
0.9	0.9	0.45
0.8	0.8	0.4
0.7	0.7	0.35
0.6	0.6	0.3
0.5	0.5	0.25
0.4	0.4	0.2
0.3	0.3	0.15
0.2	0.2	0.1
0.1	0.1	0.05
0.09	0.09	0.045
0.08	0.08	0.04
0.07	0.07	0.035
0.06	0.06	0.03
0.05	0.05	0.025
0.04	0.04	0.02
0.03	0.03	0.015
0.02	0.02	0.01
0.01	0.01	0.005
0	0	0

[1] The local abundance index represents an estimate of the proportion of the Delta smelt population that occurs near the power plants. For a given month, a local abundance index of 1 means out of all of the different surveys and survey locations used, Delta smelt only occurred at the sites near the plants and only in that month. A local abundance of 0.5 means that the surveys estimate that 50% of the Delta smelt population occurred near the power plants for a given month. The adjustment factor is multiplied by the base mitigation amount to determine the actual mitigation amount. Hence, a high local abundance results in a high mitigation amount and a low local abundance results in a low mitigation amount. In addition, the adjustment factor also incorporates CDFG's fall midwater trawl estimate of Delta smelt abundance. If the fall midwater trawl index is greater than 235 then the population is not at dangerously low levels and the mitigation adjustment is half of the local abundance index, which results in reduced mitigation. If the fall midwater trawl index is less than or equal to 235 then the populations is at dangerously low levels and the mitigation adjustment is the same as the local abundance index.

In summary, the resulting mitigation adjustment is equal to the local abundance index when the fall midwater trawl Delta smelt index (FMWT) is less than or equal to 235 and the mitigation adjustment is equal to half of the local abundance estimate when the fall midwater trawl Delta smelt index is greater than 235.

if FMWT <= 235 then the mitigation adjustment = local abundance index,
if FMWT > 235 then the mitigation adjustment = local abundance index / 2.

Example - Based on Pittsburg Power Plant, July of 1990 simulated VSD operational information and actual fisheries monitoring data:

a. July accumulated approximately 4 percentage points above threshold limits.

b. From Table F-2 and the formula above for Pittsburg, the base mitigation would be $300.

c. Two surveys occurred in that month, one survey caught 11 Delta smelt locally in July out of 123 Delta smelt total for the year. The other survey caught 2 Delta smelt locally for July out of 379 Delta smelt total for the year. The local abundance index would be the average of the proportions caught near the power plant, ((11/123)+(2/379))/2, or 0.0473.

d. The fall-midwater trawl Delta smelt index for 1990 was 363 (>235), hence the mitigation adjustment would half of the local abundance index (0.0473/2), or 0.0237, resulting in a mitigation at the end of the year of $8 for July 1990 (formula above and Table F-3).

The resulting equations would be:

Base mitigation = percentage points of exceedance * $75 per percentage point = 4 * $75 = $300
Mitigation adjustment = local abundance index/2 = average(11/123,2/379)/2 = 0.0237
Actual mitigation = base mitigation * mitigation adjustment = $300 * 0.0237 = $8

During the VSD simulation period, abundance indices were typically 0.1 or less. However, at the Pittsburg Power Plant, the maximum index was 0.19, but that occurred during a month where there was no exceedance and, therefore, no compensation.

SIMULATION OF COMPENSATION METHOD

Simulation of Power Plant Circulating Flows under VSD Operation and Exceedance Levels

Figures F-1 and F-2 depict the 7-day running average simulated circulating water flow under VSD operation for each plant. If the 7-day average flow for the Pittsburg Power Plant goes above the 80% of design flow threshold level then the plant accumulates percentage points of exceedance. The exceedance is the percentage points above the threshold level. For example, if the 7-day average flows for a week are 82%, 84%, 85%, 86%, 88%, 85%, and 79% of design flow, then the plant accumulates 2 + 4 + 5 + 6 + 8 + 5, or 30 percentage points of exceedance for that week. The daily percentage points of exceedance were summed together for each month and are presented in the bar graph at the top of Figures F-1, F-2, F-7, and F-8.

Delta Smelt Catch Near Power Plant and in entire Bay-Delta Survey Area

Figures F-3 through F-5 depict local (near power plants) and total catch of Delta smelt by survey and Figure F-6 is a graph of the annual Delta Smelt Fall Midwater Trawl Index. Figures F-3 and F-4 show the catch of Delta smelt near each plant by survey. For each survey, the bars represent the summed catch of Delta smelt for all sites located near a power plant (e.g., if there were 5 Summer Townet sites near Pittsburg in June 1992, then the bar is the sum of the catch of all 5 townets). Figure F-5 depicts the total catch (all sites) of the surveys by month. Local catch data from 1997 was not available in time to include into our index calculations.

Simulation of Compensation

Figures F-7 and F-8 depict the method of estimating compensation for each plant. The monthly exceedance-days were calculated based on the rules discussed above and used in the formulas described above.

Potential Worst Case Annual Mitigation Based on Historical Data

The examples presented here use data provided by the agencies and PG&E during 1990, 1991, 1993, 1994, 1995, and 1997. These years were chosen to reflect a range of circulating water flows and varying water year types (i.e., normal, wet, and dry). These are the same years used in the VSD analysis presented in Appendix E.

The worst conditions for each month were extracted from the data sets to simulate the worst case annual mitigation amount. To clarify, the highest actual percentage points of exceedance in the dataset under VSD operation, the lowest mid-water trawl index, and the highest local abundance index for a given month were selected, independent of each other, such that they may or may not come from the same month in the same year. The lowest annual fall mid-water trawl Delta smelt index to occur within the data set was 101.2.

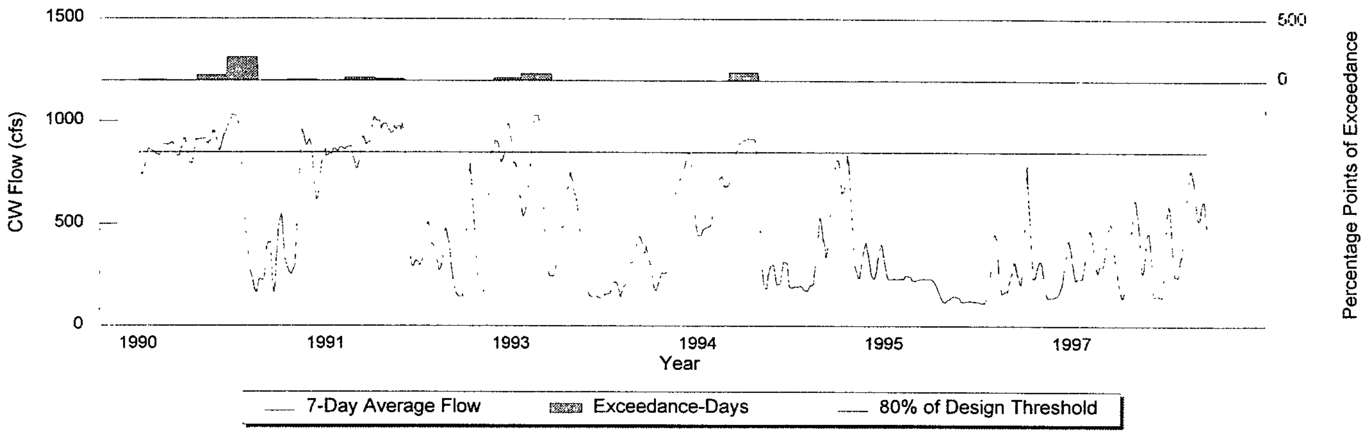


Figure F-1. VSD Cooling Water Circulation Flow at Pittsburg Power Plant for February through July with 80% Threshold Line and Exceedance-Days (1990, 1991, 1993, 1994, 1995, and 1997)

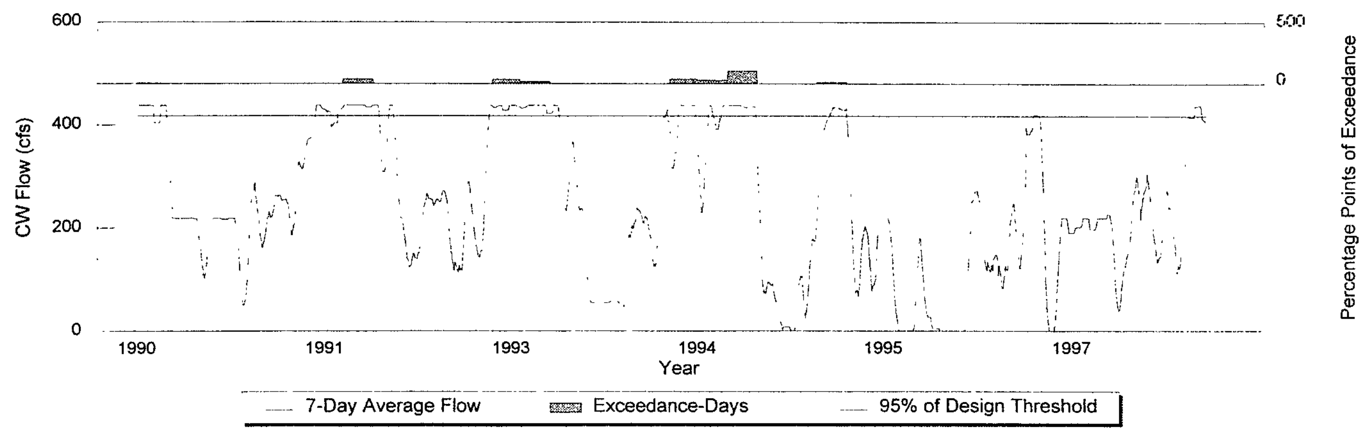


Figure F-2. VSD Cooling Water Circulation Flow at Contra Costa Power Plant for February through July with 95% Threshold Line and Exceedance-Days (1990, 1991, 1993, 1994, 1995, and 1997)

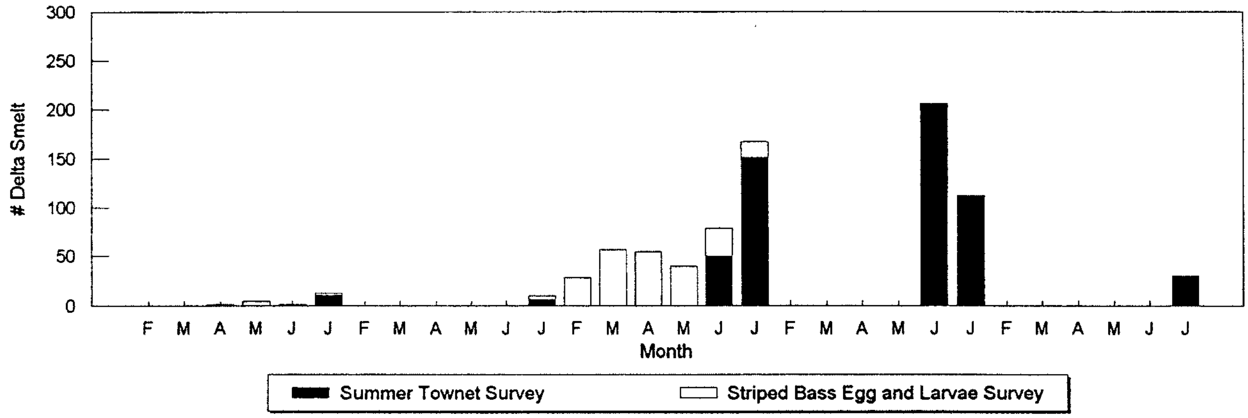


Figure F-3. Total Number of Delta Smelt Caught near the Pittsburg Power Plant for February through July for years 1990, 1991, 1993, 1994, and 1995

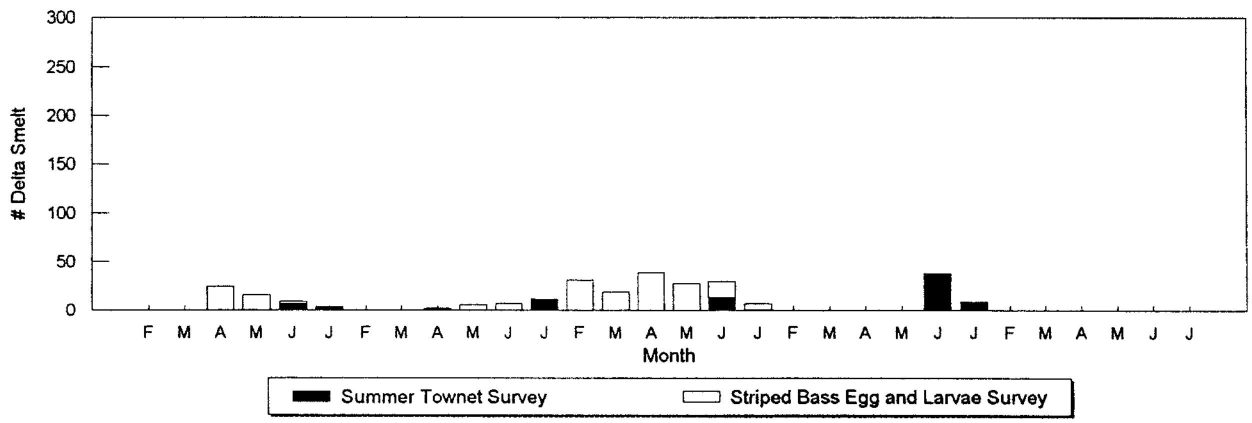


Figure F-4. Total Number of Delta Smelt Caught near the Contra Costa Power Plant for February through July for years 1990, 1991, 1993, 1994, and 1995

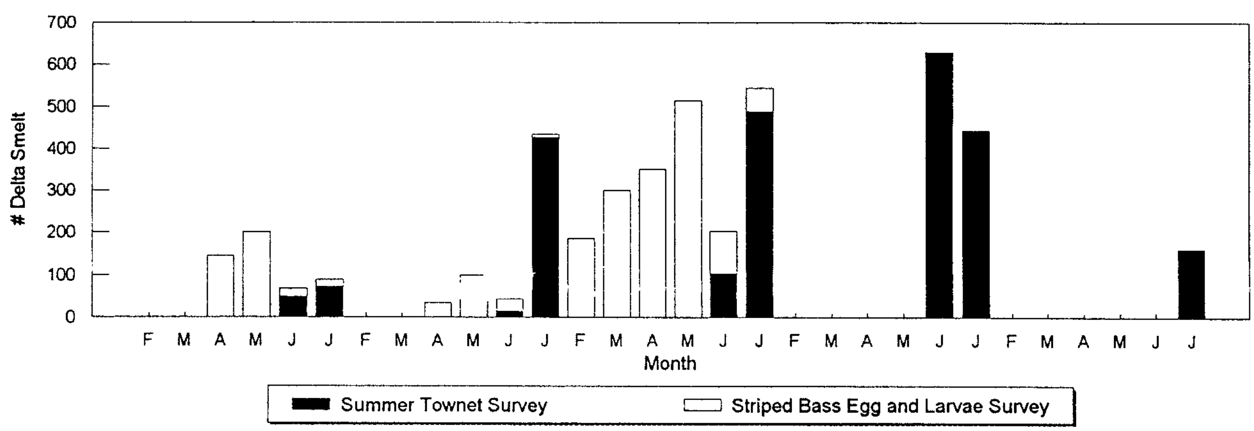


Figure F-5. Total Number of Delta Smelt Caught in the Bay-Delta Area for February through July for years 1990, 1991, 1993, 1994,

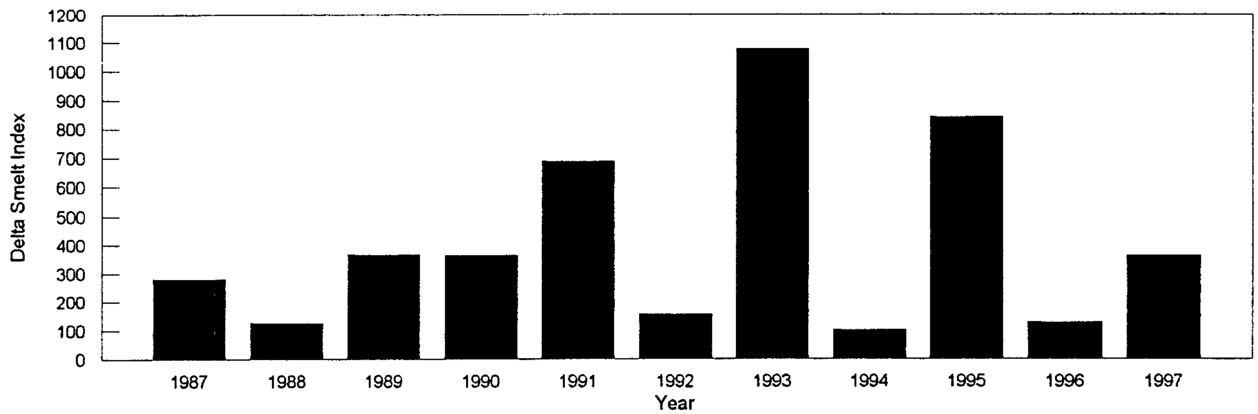


Figure F-6. Annual Delta Smelt Fall Midwater Trawl Index (1987 - 1997).

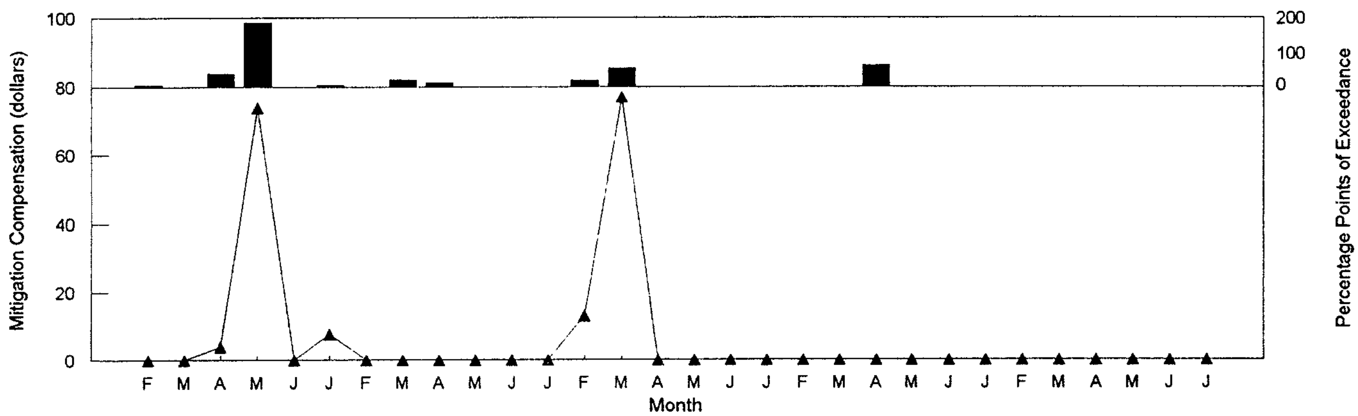


Figure F-7. Monthly Simulation of Compensation at the Pittsburg Powerplant for February through July for 1990, 1991, 1993, 1994, and 1995

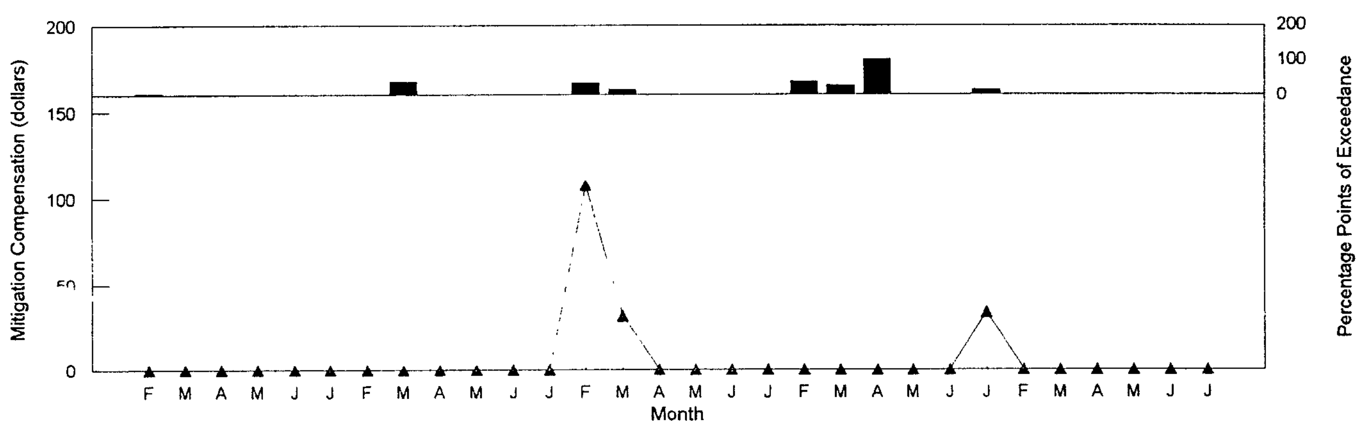


Figure F-8. Monthly Simulation of Compensation at the Contra Costa Powerplant for February through July for 1990, 1991, 1993, 1994, and 1995

Table F-4 illustrates the potential worst case mitigation for the Pittsburg Power Plant based upon the lowest annual fall mid-water trawl Delta smelt index, the highest local abundance index and the maximum cumulative percentage points of exceedance for a month. These numbers are not for any one particular year.

Table F-4. Potential Worst Case Mitigation Amount for Pittsburg Power Plant

MONTH	Fall Mid-water Trawl Index	Abundance Index	Percentage Points	Base Mitigation Level	Mitigation Adjustment	Actual Mitigation
February	101.2	0.019	18.7	$1,403	0.019	$26.65
March	101.2	0.038	54.3	$4,073	0.038	$154.76
April	101.2	0.036	63.1	$4,733	0.036	$170.37
May	101.2	0.027	187.3	$14,048	0.027	$379.28
June	101.2	0.192	0	$0	0.192	$0.00
July	101.2	0.133	4.3	$323	0.133	$42.89
					Total	**$773.95**

Table F-5 illustrates the potential worst case mitigation for the Contra Costa Power Plant based upon the lowest annual fall mid-water trawl Delta smelt index, the highest local abundance index and the maximum cumulative percentage points of exceedance for a month. These numbers are not for any one particular year.

Table F-5. Potential Worst Case Mitigation Amount for Contra Costa Power Plant

MONTH	Fall Mid-water Trawl Index	Abundance Index	Percentage Points	Base Mitigation Level	Mitigation Adjustment	Actual Mitigation
February	101.2	0.021	38.3	$11,490	0.021	$241.29
March	101.2	0.013	38.4	$11,520	0.013	$149.76
April	101.2	0.066	102.6	$30,780	0.066	$2,031.48
May	101.2	0.092	0	$0	0.092	$0.00
June	101.2	0.114	0	$0	0.114	$0.00
July	101.2	0.031	13.5	$4,050	0.031	$125.55
					Total	**$2,548.08**

METHOD FOR ASSESSING COMPENSATION FOR WINTER-RUN CHINOOK SALMON

February and March have been identified as the critical time period for juvenile winter-run chinook salmon in the Delta. Therefore, compensation in February and March is determined by three factors:

a. the degree to which the power plants exceed prescribed circulating water flow thresholds,
b. the amount of compensation per percentage points of exceedance, and
c. the estimated winter-run chinook salmon population size

a. Power Plant Operation in Excess of Prescribed Limits

The extent that a power plant exceeds its prescribed threshold flow in February and March will be measured as the sum of the percentage points of exceedance of the 7-day running average operation. For example, if the 7-day running average exceeded the 95% of design flow threshold at the Contra Costa Power Plant Units 6 and 7 by a total of 10% over 10 days (e.g. 1% per day) during February then the percentage points of exceedance for the month would be 10. Full operation (100%) for a 30-day month would be 150 percentage points of exceedance (30 times 5).

b. Compensation Amount Based upon Level of Exceedance

Based on the 7-day running average of cooling water flow, the mitigation amounts per percentage point of exceedance were determined for each power plant for a maximum potential mitigation of $1,500 per day when cooling water flow is at design levels (100%). This resulted in $75 per percentage point of exceedance at Pittsburg Power Plant and $300 per percentage point of exceedance at Contra Costa Power Plant.

c. Estimated Winter-Run Chinook Salmon Population Size

Compensation for exceeding prescribed operation limits would also consider the estimated male/female ratio of the winter-run chinook salmon run size as determined by NMFS for the preceding year. The estimated female run size will provide an indication of overall winter-run chinook salmon abundance. If the estimated number of females from the preceding year is low then the mitigation compensation would be greater since fewer eggs and subsequent juveniles are produced. A run size of 10,000 females was selected as a benchmark or threshold population level. Compensation is increased as the population level decreases below the fish 10,000 female benchmark.

In addition, a local abundance index representing the presence of juvenile winter-run chinook salmon near the power plants was considered but not implemented in the mitigation compensation program. Currently, there is very limited survey information on winter-run chinook salmon abundance in the Delta. Therefore, an index of local abundance near the power plants was not available. However, if surveys targeting winter-run chinook salmon in the future are initiated, they will be evaluated for inclusion into the winter-run chinook salmon mitigation compensation program.

ESTIMATING COMPENSATION

Compensation for exceeding circulating water thresholds above predetermined threshold volumes is assessed based on three basic parameters:

a. The extent of operation above the prescribed limits as measured by the number of percentage points the 7-day running average is above the prescribed 80 and 95% circulating water thresholds.

b. The amount of compensation per percentage point of exceedance of the respective 80 and 95% thresholds, $75 for Pittsburg and $300 for Contra Costa per percentage point of exceedance.

c. The estimated number of female winter-run chinook salmon from the preceding year's NMFS winter-run population estimate.

Compensation is assessed as follows:

a. A base level of mitigation is calculated based upon exceeding the cooling water flow threshold (80% of design flow at Pittsburg and 95% of design flow at Contra Costa). The base level mitigation also represents the theoretical maximum mitigation which is adjusted later to incorporate biological information. When the average flow has exceeded the threshold level, the percentage points of exceedance is calculated by subtracting the threshold percentage from the actual 7-day average flow percentage of design.

   Percentage points of exceedance = (7-day average flow/design flow) - 80% (Pittsburg),
   Percentage points of exceedance = (7-day average flow/design flow) - 95% (Contra Costa).

b. The base mitigation amount is the number of percentage points of exceedance the daily 7-day average is above threshold multiplied by $75 for Pittsburg or $300 for Contra

Costa (Table F-2). Hence, only when the thresholds have been exceeded, is the daily base level of mitigation calculated as follows.

Base mitigation = percentage points of exceedance * $75 per percentage point (Pittsburg),
Base mitigation = percentage points of exceedance * $300 per percentage point (Contra Costa).

c. A mitigation adjustment is calculated at the end of the year based upon the number of female winter-run salmon from the previous year (Table F-6). The adjustment serves to incorporate the potential abundance of juvenile winter-run chinook salmon into the calculation of the mitigation amount. The adjustment is multiplied with the base mitigation to determine actual mitigation at the end of the year,

actual mitigation = base mitigation * mitigation adjustment.

The annual number of female winter-run chinook salmon run size from the preceding year is used to determine the mitigation adjustment. When the number of females is less than 10,000 fish, then the population is considered to be at risk and the mitigation adjustment increases as the estimated run size falls (Table F-6),

However, when the number of females is greater than 10,000, then the population is considered to be not at high risk and the mitigation adjustment is 0 (Table F-6). For example, if the number of female winter-run chinook salmon for 1991 was 1,350 fish, then the mitigation adjustment for 1992 would be 0.9 and the base mitigation for February and March of 1992 would be multiplied by 0.9.

Table F-6. Mitigation Adjustment Factor Based Upon the Previous Year's Number of Females in the Estimated Winter-Run Salmon Population as Determined by NMFS

Number of Females	Mitigation Adjustment
10,000	0
9,500-9,999	0.05
9,000-9,499	0.1
8,500-8,999	0.15
8,000-8,499	0.2
7,500-7,999	0.25
7,000-7,499	0.3
6,500-6,999	0.35
6,000-6,499	0.4
5,500-5,999	0.45
5,000-5,499	0.5
4,500-4,999	0.55
4,000-4,499	0.6
3,500-3,999	0.65
3,000-3,499	0.7
2,500-2,999	0.75
2,000-2,499	0.8
1,500-1,999	0.85
1,000-1,499	0.9
500-999	0.95
0-500	1

Example - Based on Contra Costa Power Plant, March of 1991 simulated VSD operational information and actual fisheries monitoring data:

a. March accumulated approximately 38 percentage points above threshold limits.

b. From Table F-2 and the formula for Contra Costa shown below, the base mitigation would be $11,400.

c. The estimated female winter-run chinook salmon run size from 1990 was 221 (assuming a 50:50 ratio of males to females) fish therefore, the mitigation adjustment would be 1.0 (Table F-6). Resulting in a mitigation at the end of the year of approximately $11,400 for March 1991 (formula above).

The resulting equations would be:

> Base mitigation = percentage points of exceedance * $300 per percentage point = 38 * $300 = $11,400
> Mitigation adjustment = 1.0
> Actual mitigation = base mitigation * mitigation adjustment = $11,400 * 1.0 = $11,400

From the 1990 to 1997 simulation period, the mitigation adjustment varied from 0.8 to 1.0.

SIMULATION OF COMPENSATION METHOD

Simulation of Power Plant Circulating Flows under VSD Operation and Exceedance Levels

Figures F-1 and F-2 depict the 7-day running average of simulated circulating water flow under VSD operation for each plant. If the 7-day running average flow for the Pittsburg Power Plant goes above the 80% of design flow threshold level then the plant accumulates percentage points of exceedance. The exceedance is the percentage points above the threshold level. For example, if the 7-day average flows for a week are 82%, 84%, 85%, 86%, 88%, 85%, and 79% of design flow, then the plant accumulates 2 + 4 + 5 + 6 + 8 + 5, or 30 percentage points of exceedance for that week. The daily percentage points of exceedance were summed together for each month and are presented in the bar graph at the top of Figures F-1, F-2, F-10, and F-11.

Winter-Run Chinook Salmon Run Size

Figure F-9 is a graph of the winter-run chinook salmon run size as estimated at Red Bluff diversion dam from 1976 to 1996. This table is presented as a surrogate for the number of females in the annual estimated winter-run population estimate. For the purposes of this simulation, it was assumed that there was a 1:1 ratio of males and females.

Simulation of Compensation

Figures F-10 and F-11 depict the method of estimating compensation for each plant for 1990, 1991, 1993, 1994, 1995, and 1997. The monthly exceedance-days were calculated based on the parameters discussed above and used in the formulas described above.

Potential Worst Case Annual Mitigation Based on Historical Data

The examples presented here use data provided by the agencies and PG&E during 1990, 1991, 1993, 1994, 1995, and 1997. These years were chosen to reflect a range of circulating water flows and varying water year types (i.e., normal, wet, and dry). These are the same years used in the VSD analysis presented in Appendix E.

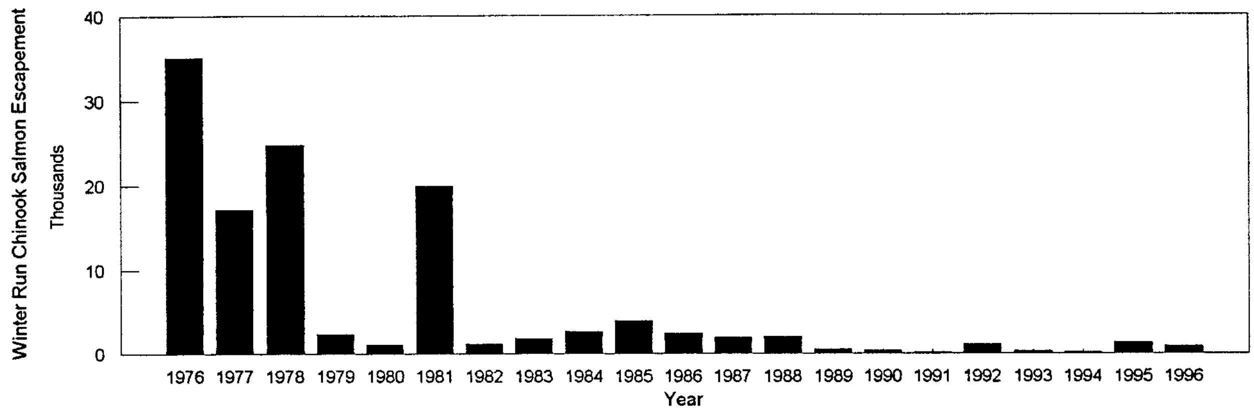


Figure F-9. Annual Winter-Run Chinook Salmon Spawning Escapements Counts at Red Bluff Diversion Dam (1976 - 1996).

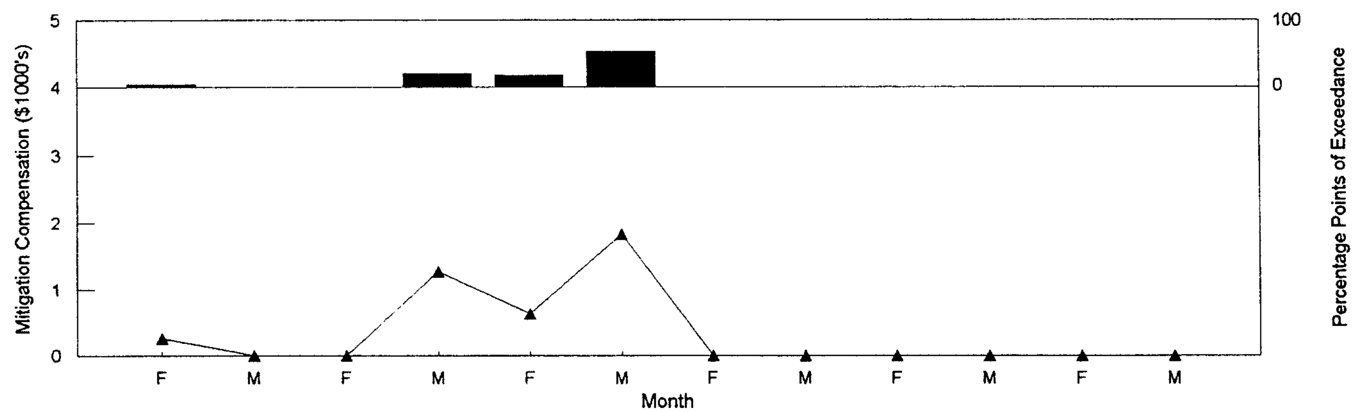


Figure F-10. Monthly Simulation of Compensation at the Pittsburg Powerplant for February through March for 1990, 1991, 1993, 1994, 1995, and 1997.

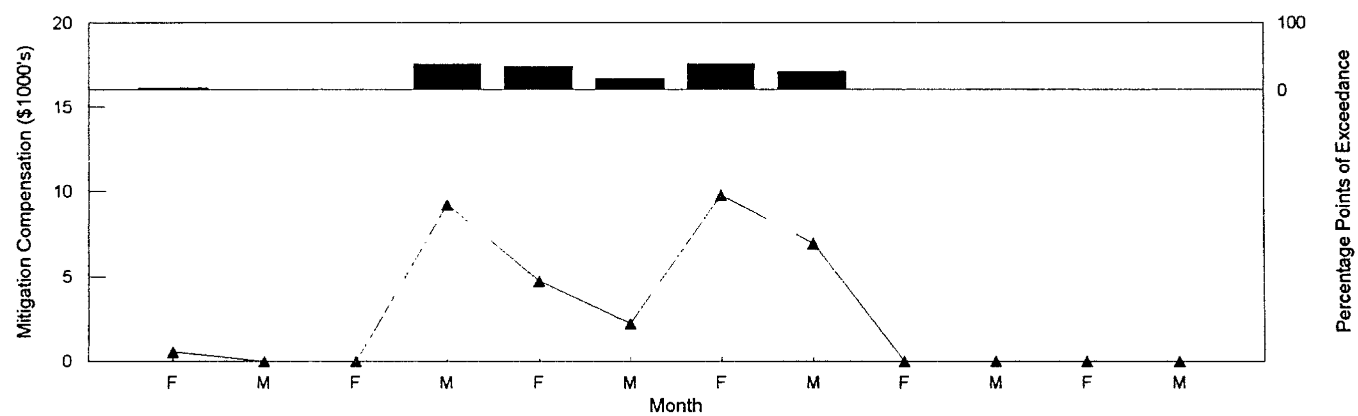


Figure F-11. Monthly Simulation of Compensation at the Contra Costa Powerplant for February through March for 1990, 1991, 1993, 1994, 1995, and 1997.

The worst conditions for each month were extracted from the data sets to simulate the worst case annual mitigation amount. To clarify, the highest actual percentage points of exceedance in the dataset under VSD operation and the lowest annual number of female winter-run chinook salmon were selected, independent of each other, such that they may or may not come from the same month or from the same year. The lowest winter-run chinook salmon run size to occur with our study years was 189 (or 90 females at an equal ratio of males to females).

Table F-7 illustrates the potential actual mitigation for the Pittsburg Power Plant based upon the lowest number of female winter-run salmon and the maximum cumulative percentage points of exceedance for a month. These numbers are not for any one particular year.

Table F-7. Potential Worst Case Mitigation Amount for Pittsburg Power Plant

MONTH	Number of Females	Percentage Points	Base Mitigation Level	Mitigation Adjustment	Actual Mitigation
February	90	18.7	$1,403	1.0	$1,403.00
March	90	54.3	$4,073	1.0	$4,073.00
				Total	**$5,476.00**

Table F-8 illustrates the potential actual mitigation for the Contra Costa Power Plant based upon the lowest female winter-run run size and the maximum cumulative percentage points of exceedance for a month. These numbers are not for any one particular year.

Table F-8. Potential Worst Case Mitigation Amount for Contra Costa Power Plant

MONTH	Number of Females	Percentage Points	Base Mitigation Level	Mitigation Adjustment	Actual Mitigation
February	90	38.3	$11,490	0.95	$11,490.00
March	90	38.4	$11,520	0.95	$11,520.00
				Total	**$23,010.00**

Combined Potential Worst Case Annual Mitigation Based on Historical Data

The combined annual mitigation is determined by summing the annual mitigation amount for Delta smelt and the annual mitigation amount for female winter-run chinook salmon for both power plants. From Table F-4 and F-5, the potential worst case annual mitigation amount incurred for Delta smelt at the Pittsburg and Contra Costa power plants would be $774 + $2,548, respectively, or $3,322. From Table F-7 and F-8, the potential worst case annual mitigation amount incurred for female winter-run chinook salmon at the Pittsburg and Contra Costa power plants would be $5,476 + $23,010, respectively, or $28,486. Therefore, the combined annual mitigation amount for both power plants would be $31,808.

APPENDIX G-1

To Come

APPENDIX G-2

To Come

CONTRA COSTA POWER PLANT
Objectives and Approaches for the Design of an Intake Aquatic Filter Barrier Post-Construction Operations and Maintenance Screen Evaluation Plan

June 19, 2000

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Approach and Objectives for the Design of a Screen Evaluation Plan for the CCPP Intake Aquatic Filter Barrier

Southern Energy (SE) has determined that the installation of a fine-mesh aquatic filter barrier (AFB) in front of the Contra Costa Power Plant's cooling water intake has a high potential to significantly reduce the entrainment losses of fish eggs and larvae and to virtually eliminate the impingement of juvenile and adult fishes. SE has selected Gunderboom as its vendor and has authorized the conceptual design, engineering plans, and preliminary field flow tests. The use of an AFB at the Contra Costa Power Plant (CCPP) will be evaluated during the course of SE's Habitat Conservation Plan (HCP) and Incidental Take Permit (ITP) and, if effective, an AFB would be designed and placed at SEs Pittsburg Power Plant. Planning meetings have been held with federal and state resource and regulatory agencies to develop an appropriate sampling and monitoring methodology to evaluate the effectiveness of the AFB technology at the CCPP. In addition, discussions have centered on alternative intake technology.

Issues of particular interest and discussion with the various agencies have focused on barrier effectiveness, maintenance and operations associated with siltation and biofouling, loss of enclosed shallow water habitat, larval impingement survival, and predator-prey interactions. Many of these issues would be addressed by the results of data collection efforts at the site before and after installation of the barrier. Guidelines for the development of post-construction evaluation and assessment plans and operations and maintenance plans for fish screens were recently published by the US Fish and Wildlife Service and US Bureau of Reclamation (1999). These guidelines were used to develop both objectives and conceptual approaches outlined and described in this biological monitoring and sampling plan, which presents the rationale for testing the barrier's effectiveness, describes the types of field data required, and discusses various methods to collect and utilize the data.

Project Description

Design of the AFB must meet its intended purpose of excluding small life stages of fishes and invertebrates normally subject to entrainment mortality and at the same time allow the passage of a sufficient flow of source water to meet the power plant's cooling water requirements. In particular, the AFB must be evaluated both for its potential to exclude species listed under the federal and state Endangered Species Acts and for its impacts to other sensitive species. Design of the barrier begins with the selection of a filter pore size that will exclude most larval life stages of sensitive species yet allow sufficient intake flow given the site's practical space limitations. Generally, as the AFB's porosity is decreased by smaller diameter or wider spaced openings, the surface area of the barrier must be increased to provide comparable flow rates through the AFB. Considering both design elements, a 3/32-inch diameter pore was selected to proceed with the engineering of an initial AFB design. Flow rates of 5 to 10 gpm per ft^2 are expected through the AFB material with 3/32-inch diameter pores spaced at intervals to be determined. Based on an expected flow rate of 10 gpm per ft^2 through 3/32-inch perforated material, an AFB to meet the CCPP cooling water demand of approximately 300,000 gpm would require an aquatic filter surface area of 30,000 ft^2. Thus, the AFB, as proposed, would be a total of 1,700 feet and enclose an area of approximately 8 acres.

At the present time, deployment of the AFB is planned to occur as early as November and as late as January. This is a period of the year when the abundance of larval species are at low levels prior to spawning activities associated with spring time water conditions. Out-migrating numbers of anadromous fishes are also at low levels during these months. The AFB will be deployed from an upstream mooring in an arc out to its downstream mooring. Deployment in this direction will minimize catching fishes moving with the current inside the barrier during deployment. As the barrier is being closed, which will take some time, a low frequency noise device to encourage larger fish to move downstream will be towed by a small boat crisscrossing the open space inside the AFB. The larval fish remaining inside the AFB will either develop and settle in the habitat inside the AFB or be transported by the power plant's cooling water system back to the river outside the AFB. Further, once closed, the area inside the AFB may be seined or electrofished and all sensitive species would be immediately removed and replaced in the Delta.

Protected and Sensitive Species

Several protected and sensitive fish species have been reported to occur within the estuarine habitat in the vicinity of the CCPP. These species include the listed (state and federal endangered and threatened) and species of special concern that may occur in the vicinity of the CCPP (Table 1).

Table 1. List of Special Status Species within the Vicinity of the CCPP.

Common Name	Scientific Name	State Status	Federal Status	Species Of Special Concern
Delta smelt	*Hypomesus transpacificus*	Threatened	Threatened	
Longfin smelt	*Spirinchus thaleichthys*	None	Special Concern	CDFG—Special Concern
Sacramento Winter-run chinook salmon	*Oncorhynchus tshawytscha*	Endangered	Endangered	
Central Valley Spring-run chinook salmon	*Oncorhynchus tshawytscha*	Threatened	Threatened	
Central Valley Fall/late fall-run chinook salmon	*Oncorhynchus tshawytscha*		Threatened	
Central Valley Steelhead	*Oncorhynchus mykiss*		Threatened	

Sacramento splittail	*Pogonichthys macrolepidotus*	Proposed Endangered	Threatened	CDFG—Fully Protected
Green sturgeon	*Acipenser medirostris*	None	None	

The Sacramento River system contains three runs of chinook salmon: winter, spring, and fall/late fall. Habitat utilization, the timing of adult upstream migration, spawning, egg incubation, and juvenile downstream migration distinguish the runs from each other. The Central Valley supports the largest population of chinook salmon in the State. The Bay-Delta is the migration corridor for adult salmon in-migration and smolt out-migration, and also provides rearing habitat for salmon fry. Special status salmon species in the area of the CCPP include Sacramento winter-run, Central Valley spring-run and fall/late-fall-run chinook salmon. Of particular concern is the delta smelt found in the project area from February through July.

Screen Evaluation and Monitoring Program

SE will evaluate the post-construction performance, operations and maintenance of the proposed AFB to reduce entrainment and impingement of fishes and invertebrates at the CCPP Units 6 and 7 cooling water intake system (CWIS). The performance of the AFB will be evaluated to meet the overall requirements of the state and federal ESAs as well as implement the adaptive management features of the HCP/ITP. Guidelines for evaluating anadromous fish screens developed by the US Fish and Wildlife Service and US Bureau of Reclamation (1999) were used in the proposed AFB screen evaluation plan. The plan addresses each of the five objectives suggested in the USFWS/USBR guidelines for performing screen evaluations. This AFB biological monitoring and sampling plan was based on a review of conceptual approaches and alternatives that meet the USFWS/USBR guideline's objectives.

OBJECTIVES:

A. A successful test of the AFB mechanical and electrical systems before operations including the warning and recording systems.

B. A successful test of the AFB automated air-burst cleaning system using operation and maintenance documentation provided by the fabricator to the owner/operator.

C. Evaluation of fish entrainment across the AFB through tests performed by qualified personnel using well-established methodologies. Study plans to meet this objective should include descriptions of survey equipment and methodologies, duration of the test period, frequency of monitoring, and analytical techniques.

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D. Evaluation of safe bypass of fishes and other aquatic organisms across the outer face of the AFB. Study plans may include tests of water velocity in front of the AFB and biological tests of safe passage of larvae and juveniles during the exposure season. Established methodologies will be employed whenever possible using qualified personnel.

E. Evaluate the water velocities perpendicular (approach) and parallel (sweeping) to the AFB face.

F. Identify post-construction problems and modify or retrofit appropriate solutions.

G. Report on each evaluation of AFB hydraulic and fish entrainment test with thirty days of completion.

H. Submit a time line to perform the required evaluations for agency review and approval. The evaluation portion of the post-construction evaluation and assessment must be completed prior to initiation of routine operations.

AFB Screen Evaluation Design

A. *A successful test of the AFB mechanical and electrical systems before operations including the warning and recording systems.*

A plan for testing the full complement of AFB systems will be developed and implemented during the evaluation program.

B. *A successful test of the AFB automated air burst cleaning system using operation and maintenance documentation provided by the fabricator to the owner/operator.*

The AFB automated air-burst cleaning system will be tested and calibrated during the evaluation program, and documentation of its operation and maintenance will be provided by the fabricator to the owner/operator.

C. *Evaluation of fish entrainment across the AFB through tests performed by qualified personnel using well-established methodologies. Study plans to meet this objective should include descriptions of survey equipment and methodologies, duration of the test period, frequency of monitoring, and analytical techniques.*

The presence of numerous mooring lines to anchor the AFB will likely interfere with boat operations close to the AFB. Launching a boat to tow a net inside the AFB would also present both practical and safety problems. The use of stationary pumps to collect entrained fish samples has been a proven method of collection and has been employed at the site for many years. By using a combination of shore- and barge-based pumps, several sampling locations can be sampled simultaneously with identical equipment. Pumped samples are carefully metered to produce an accurate estimate of larval concentration that is not possible with towed nets. However, pump sampling carries with it two potentially important limitations. Pump samples are collected at a relatively low rate requiring extended sampling times to acquire a sufficient sample for low concentrations of larval fishes. The fixed depth and location of the pump's intake pipe may bias the representative aspects of the sample.

A 4-inch diameter recessed-impeller pump (Homelite trash pump) will be used to collect AFB fish-entrainment evaluation samples. The pumped water samples will be filtered by 0.5 m diameter plankton nets with 0.5 mm mesh suspended in a 3-foot high by 3-foot wide cylindrical polyethylene tank. Sample volumes and flowrates will be measured with a calibrated inline flowmeter mounted in the sampling pump discharge line. The flowrate during sampling will be maintained at approximately 0.9 to 1.0 m^3/minute. This results in a sample volume of approximately 720 m^3 of cooling water per 12-hour sampling effort.

The plankton nets will be cycled at 30-minute intervals throughout the 12-hour collection period to minimize problems of net clogging and/or abrasion and mutilation of ichthyoplankton collected. The sample will then be collected by rinsing the net from the outside, concentrating the organisms in a screen-walled collection container (codend). Samples are then labeled, stained with rose bengal dye, and preserved in ETOH for subsequent sample processing.

Sample Design

Fish entrainment will be evaluated by comparing representative samples of fish eggs and larvae and invertebrates concentrations (#/m^3) collected inside and outside the AFB. The ratio of entrained and source water taxa concentrations (proportional entrainment [PE]) can be tested statistically for significant differences between ratios.

Methods to collect biological samples to test the barrier's effectiveness are adapted to the various sampling locations and life stages included in the study.

Ichthyoplankton samples will be collected from:

1. Inside the Units 6 and 7 CWIS,
2. Outside the AFB in each third of the AFB arc, and
3. Inside the AFB in each third of the AFB arc.

Water quality collection data associated with biological sampling will be standardized for each of the various sampling locations. Information on tidal cycle times and currents will be documented for samples collected outside the AFB.

The AFB fish-entrainment evaluation samples will be collected twice weekly over a 12-hour period. This frequency is consistent with the Striped Bass Monitoring Program's (SBMP) routine monitoring of 12-hr collection periods once or twice per week. A 12-hour sample period will cover two tidal cycles each sampling effort. Samples will be collected from approximately 3 pm to 3 am allowing for a comparison of diurnal differences in sampling densities.

Sampling Frequency and Duration

Sampling frequency and duration is designed to address the short-term data needs for the evaluation of AFB fish entrainment. Collection of the AFB fish-entrainment samples will begin February 1 and continue until July 31 based on the presence of the larvae of important species that are susceptible to entrainment shown in Table 2. SBMP entrainment abundance monitoring begins the first week of May and continues until 15 July of each year or until the end of the entrainment period, whichever is earlier.

Several species with special status (Table 1) are found in the vicinity of the CCPP. The seasons during which the different life stages of these species may be susceptible to either entrainment or impingement at CCPP are shown in Table 2. All of the larval forms of the special status species susceptible to entrainment may be present near the CCPP from December through July. Juveniles of all the special status species except the salmonids may be present in the CCPP area from May through December. Adults of delta smelt, longfin smelt, and Sacramento splittail may be present all year near the CCPP.

Table 2. Seasons when Various Life Stages of Special Status Species may Occur in the Vicinity of the CCPP.

Common Name	Scientific Name	Eggs	Larvae	Juvenile	Adult
Delta smelt	*Hypomesus transpacificus*	Not applicable*	December through July; low outflow years late March to mid-May	July through December	All Year
Longfin smelt	*Spirinchus thaleichthys*	Not applicable*	December through June	May through December	All Year
Winter-run chinook salmon	*Oncorhynchus tshawytscha*	Not applicable**	Not applicable**	January through May	November through July
Spring-run chinook salmon	*Oncorhynchus tshawytscha*	Not applicable**	Not applicable**	Late November through mid-May	March through July
Fall/late fall-run chinook salmon	*Oncorhynchus tshawytscha*	Not applicable**	Not applicable**	Mid-March through June and October through December	Mid-October through February
Steelhead	*Oncorhynchus mykiss*	Not applicable**	Not applicable**	Mainly spring, but may be present all year	July through March
Sacramento splittail	*Pogonichthys*	January through	January through	May through	All Year

	macrolepidotus	July	July	July	
Green sturgeon	*Acipenser medirostris*	Not applicable*	Spring through Summer	Summer through Fall	Late February through July

Sources: Wang, 1986; PG&E, 1998; CDFG, 1999

*Eggs are adhesive and not susceptible to entrainment.

**These life stages do not occur in the vicinity of the CCPP.

Sample Location

The initial stage of the fish entrainment evaluation program will begin with a design to intensively sample several locations along the AFB to determine the minimum number and most representative sampling location(s) for the longer-term evaluation. Ideally, a single representative AFB location will be identified that can be sampled from shore along with power plant entrainment sample collections. The evaluation program design is intended to adapt to the results of ongoing AFB monitoring and operational results. Representative concentrations of entrainable organisms will be collected from inside and outside three areas of the AFB. One sampling location will be located in each third of the AFB arc. Two locations will be sampled remotely from shore by intake lines running along the AFB boom to the sampling location. The third location will be sampled from a barge anchored on the outside center of the middle third of the AFB arc (Figure 1) **[NOTE: THIS FIGURE ONLY SHOWS BARGE SAMPLING ON ONE SIDE OF THE AFB]**. The proposed sample collection methods will be identical to those used to collect entrainment samples during the SBMP (Tenera, 1998) as summarized above. A single representative sampling location will be permanently established based on the preliminary results of the samples collected from the three stations spaced along the arc of the AFB. Support vessels will maneuver the barge into position during daylight hours before the evening survey and retrieve it when it can be safely maneuvered from its moorings.

Pumped entrainment samples from the barge pumping station will be collected at the same time as the land-based CWIS entrainment sampling at the Units 6 and 7 discharge and the two shore-side arcs of the AFB. All three of the AFB samples and the Units 6 and 7 pumped samples will be collected over the same 12-hour survey period in 30-minute intervals. The targeted water flow rate per pump will be approximately 1 m^3 per minute. The total volume of the 30-minute samples will be approximately 30 m^3. In order to closely match the volume of the paired CWIS entrainment sample, operators onboard the barge will be in communication with their shore-based crew and will suspend pumping onboard the barge according to reports from shore of their projected 30-minute volumes. Water will be filtered through a 505-μm mesh plankton net suspended over the side of the barge. The large diameter net will be partially submerged to avoid damage to larval specimens from the pump's discharge flow into the filter net. Sample volumes will be measured with a calibrated in-line flowmeter. The water level surrounding the net will be maintained below the level of the net mouth to assure that no portion of the sample is lost.

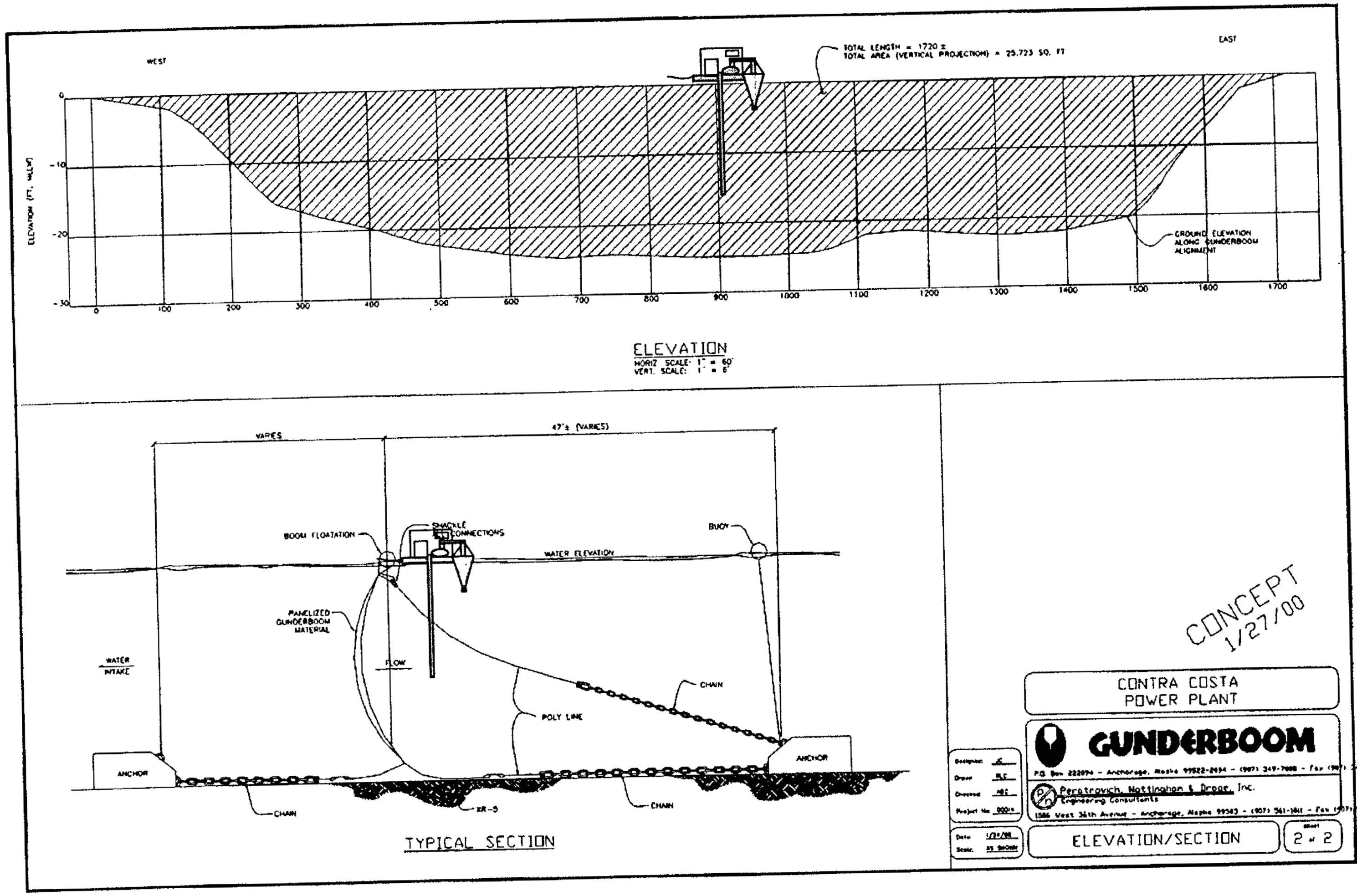

Figure 1. Barrier sampling.

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Laboratory Processing Procedures

Laboratory-processing procedures will be identical to procedures employed in the SBMP, with the exception that all specimens will be identified and representative length frequencies will be collected from all species. All ichthyoplankton identifications will be made to the lowest taxonomic level practical. Taxonomy of estuarine fish eggs is difficult; eggs of striped bass and northern anchovy will be identified when possible. A minimum of twenty percent or 30 individuals of all larval fishes in each sample will be measured to the nearest tenth of a millimeter.

Quality Control Program

A quality control (QC) program is designed to monitor the sorting accuracy of each individual sorter. A sorter and taxonomist will be required to maintain an accuracy of 90 percent. If a sample does not meet the 90 percent accuracy rate the following samples will be re-identified until 10 consecutive samples meet the criteria. This QC program will remain in effect during the entire laboratory processing effort. In addition to this in-house QC program, an additional 5 percent of the total number of samples will be sent to off-site taxonomic experts for verification.

Data Analysis

The data in this study will be analyzed using analysis of variance (ANOVA) to test the hypothesis that there is no difference between the estimates of mean concentration of entrained organisms (treatment) and source water (control) after the installation of the aquatic barrier. Data on the concentrations in the two periods will be used to determine if statistically significant changes have occurred in both the control (source water) and treatment (entrainment) over the period of study.

Data used in the ANOVA model will be obtained by computing a mean concentration for the source water station(s) for each survey and then calculating a difference, or delta, for each entrainment sample's corresponding mean concentration. The delta values will be computed using the formula x, C - Xi' (the mean abundance for the control stations (xic) minus the mean abundance (xi') for entrainment each survey i). This convention will be used instead of the formula (x,' - xic) (Stewart-Oaten et al., 1986) so that the sign (positive or negative) of the delta reflects the direction of change relative to the control (source water).

All hypothesis tests will use a probability level of 90 percent to determine significance. A level of 90 percent is chosen over the more commonly used 95 percent to increase the statistical power of the tests, thereby decreasing the probability of making a Type II error (i.e., incorrectly concluding that there was no effect when an effect actually occurred). This lower probability level slightly increases the likelihood of finding significant changes where none might occur (Type I error). The statistical power of a test is a measure of the probability of correctly concluding that a change occurred. In these analyses, power will be also calculated as the ability of the test to detect a theoretical 50 percent change between entrainment and source water concentrations.

Schedule

The schedule to collect entrainment and source water samples is predicated on the assumption that the AFB will be installed by February 1, 2001. Baseline sampling, the "before" portion of the Before and After Control Impact (BACI) model, will begin a minimum of two weeks prior to installation of the AFB..

Larval entrainment and source water sampling will set the end date for sampling. Depending upon the start date, entrainment and source water sampling needs to encompass the entrainable larval season typically extending from February to July. The completion of the sampling program will be adjusted appropriately. Each survey and monitoring element of the AFB fish screen evaluation program will be conducted to take advantage of real time results to adjust sampling locations, frequencies, and methodologies. Using adaptive management techniques, the early stages of the evaluation program can be quickly adjusted to both physical and biological conditions in field. Patterns in variance structures of collected data can be employed to modify sampling designs to improve their efficacy. The use of information on larval fish entrainment that must be processed in the laboratory to modify sampling designs will depend upon laboratory capabilities to rapidly process ichthyoplankton samples.

SE proposes to develop a Biological Monitoring Advisory Team comprised of representatives of USFWS, NMFS, and CDFG to evaluate the biological monitoring program and make recommendations to ensure that the sampling program effectively addresses issues of impacts to listed and sensitive species.

D. *Evaluation of safe bypass of fishes and other aquatic organisms across the outer face of the AFB. Study plans may include tests of water velocity in front of the AFB and biological tests of safe passage of larvae and juveniles during the exposure season. Established methodologies will be employed whenever possible using qualified personnel.*

- Conduct routine acoustical doppler (ACDP) surveys of fish biomass, particularly large potential predator targets, along the outer surface of the AFB. Surveys would begin following installation and operation of the AFB and continue, until sufficient information is available to make conclusions regarding predators. . Both sampling frequency and time of year for sample collections will be determined by initial and ongoing results. ACDP biomass surveys will be conducted in conjunction with survey of AFB screen surface approach and sweeping velocities (Objective B).

- Diver surveys of AFB fish biomass as conditions allow.

- Studies of larval impingement effects will be designed to address questions remaining from the results of impingement research at the Lovett Generating Station. Studies of AFB impingement effects will require a laboratory setting to investigate the anticipated small-scale effects under carefully controlled conditions. Several preliminary designs have been considered involving various modifications of larval test flumes. Details of the studies will be provided as soon as the best approach can be determined based on cost and feasibility as well as the location of suitable, existing test facilities.

E. *Evaluate the water velocities perpendicular (approach) and parallel (sweeping) to the AFB face.*

Acoustical doppler current profiler (ADCP) surveys of the AFB's outer surface of approach and sweeping velocities will be conducted. Surveys will be conducted using deck mounted ADCP instrumentation flown at a safe distance from the AFB mooring line. Typically, ADCP equipment with yawl and pitch compensation are deployed from a vessel's forward gunnels or side-mounted towing vehicle. Instrumentation placed on a side-mounted sled would enable the towing vessel to safely stand off from the AFB's mooring lines while on its survey track parallel to the AFB. ADCP signal processing bins can be adjusted to the most useful level of resolution for both AFB screen approach and sweeping velocities. AFB fish biomass (Objective A) acoustical data will be collected during the AFB screen velocity surveys.

F. *Identify post-construction problems and retrofit with appropriate solutions.*

Systematic plans and procedure will be developed and implemented to identify and track AFB problems and corrective actions.

G. *Report on each evaluation of AFB hydraulic and fish entrainment test within thirty days of completion.*

All larval fish entrainment sampling results and AFB hydraulic survey data will be processed and reported in data summary reports within 30 days. The program goal will be to have the sampling and survey of both study elements processed within 2-5 days and available to the AFB evaluation's adaptive management process. The data will be summarized from these monthly reports and submitted in semiannual and annual reports.

H. *Submit a time line to perform the required evaluations for agency review and approval. The evaluation portion of the post-construction evaluation and assessment must be completed prior to initiation of routine operations.*

The AFB's program director working with the project's engineering, fabrication, and installation team will prepare project scheduling timelines. Based on this project timeline, fish entrainment and hydraulic surveys and monitoring schedules will be developed for the collection, laboratory processing and reporting of AFB field performance information. The design and conduct of laboratory tests to study the AFB impingement survival will be separately scheduled, as necessary.

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CONTRA COSTA POWER PLANT

Conceptual Framework: Maintenance and Operations Plan for an Aquatic Filter Barrier

June 15, 2000

Southern Energy Delta, LLC

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Maintenance and Operations

1. Introduction

The effectiveness of the Contra Costa Power Plant Aquatic Filter Barrier (AFB) system, an application of the Gunderboom, Inc.'s patented Marine/Aquatic Life Exclusion System™ (MLES™), depends on a number of factors:

a) Sealing of the bottom of the AFB to the substrate and riparian area such that no gaps are established and flotation of the top portion of the AFB such that water is not entering the interior without passing through the AFB panels;

b) Anchoring and tensioning of the AFB so that it maintains appropriate overall shape and does not move from its location;

c) Filtering integrity of the AFB panels is essential to meeting operational goals. The AFB panels must pass water at the required rates to service the cooling water intake; yet continue to prevent sensitive life stages of aquatic organisms from passing through the fabric where they may be subject to injury. The AFB is affected by debris, particles and detritus and, therefore, must be cleaned periodically. For this reason, the Gunderboom Air-burst™ cleaning system must be operational, including related valves, monitoring equipment and the like.

The deployment and operation of the AFB must take into account the site and any unique configuration of the AFB. Characteristics that may be important to operational and maintenance measures are the AFB's pore size, pumping head and water passage rate through the AFB, bottom topography, turbidity characteristics of the water, water column depth, and hydraulic characteristics of the water body into which it will be placed, etc. Much has been learned from the use of AFBs in other settings, for example on the Hudson River in New York. The prime vendor and Southern Energy's experience with AFBs on the Hudson have helped to guide the draft plan for maintenance and operation of the AFB.

In addition to the AFB boom, curtain and associated mooring system, the AFB at Contra Costa includes the installation of an electrically driven air compressor, computer control panel, supply and control air hoses, "Air-burst"™ control valves, load cells, head differential monitors and a current speed and direction unit.

2. AFB Description

The Gunderboom filter fabric is a non-woven polypropylene/polyester fabric and is suspended in the water column much like a boom or seine. At CCPP, the boom will be approximately 1,700 feet long and will be deployed in an elongated semicircle surrounding the area of the intake, starting from and ending at shore points approximately 1,000 feet apart. The depth dimension of the filter fabric will vary in depth as the average water depth varies. At its maximum reach from shore, approximately 340 feet, the AFB would be placed in a water depth of twenty-five (25) feet. The AFB would encircle a total of some eight (8) acres of surface water.

The base of the boom will make contact with the muddy bottom in a swath that is approximately ten (10) toward the exterior of the AFB arc and four (4) feet toward the inside of the AFB arc for a total of some fifteen (15) feet. The AFB would be tethered at the Contra Costa site by approximately 90 anchors. The dimensions of each anchor are anticipated to be 7 feet x 7 feet wide and 4 feet in height. These anchors would be placed both inside and outside the enclosed gunderboom to maintain its shape and rigidity. Approximately thirty anchors would be placed inside the gunderboom and sixty anchors placed outside the gunderboom. The anchors would extend out to another fifty (50) feet away from the AFB at a water depth of approximately twenty-six (26) feet.

Several air lines of approximately 1 inch in diameter or less would be laid on the inside of the gunderboom from the shoreline to the gunderboom panels. Each AFB panel will have an air valve operated by a pneumatic control system that opens the valve to air lines terminating in a "delta diffuser"™ that releases a burst of air in the base of each two-layered panel to clear the fabric of any accumulated sediment and debris. These air lines would be used to clean suspended material from the gunderboom several times each day. In addition, cables and automating airline switching mechanisms will accompany the airlines. Finally, at both sites, a multipurpose boat launch ramp and gunderboom staging area would be placed on the shoreline. The ramps would be approximately twenty (20) feet wide x fifty (50) feet-long and extend into the water's edge approximately five feet.

Installation of the AFB would require the removal of existing riprap and a small area of emergent vegetation where each end of the gunderboom meets the shoreline. The cleared area is estimated to comprise approximately 0.04 acres. The clearing of both riprap and emergent vegetation is necessary for the gunderboom to form a complete and effective seal to prevent the entrainment of various life stages of aquatic organisms in the cooling water intake structure at the power plants.

The AFB system itself is passive in the sense that water will pass through the AFB based on differential pumping head developed by the current circulating intake system at the CCPP. The AFB system will be constructed of approximately 12 individual units that "zip" together. The AFB will be integrated with active cleaning systems requiring occasional monitoring of performance parameters.

As described above, the cleaning of the filter panel system is accomplished by sequentially injecting air into the cells that are formed in the curtain. This "Air burst™" provides the mechanism by which silt and debris are removed from the face of the curtain. The sequential "air burst" is controlled by a master computer panel that times the opening of each individual air-over-air valve that feeds to each cell. The Contra Costa system will have approximately 200 cells and corresponding air valves.

The operation of this system is automatic and self adjusts for tidal current fluctuation (changes the direction of the sequential valve opening to correspond with the river current direction) and can alter the time in-between cleaning cycles should an "event" occur that places excessive loads on the curtain. These "events" might include a "silt" event that is caused by heavy rains and the related runoff, large amounts of suspended vegetation or anything of the nature that occurs upstream of the facility and floats towards the system. The alteration of the timing of cleaning cycles is controlled by tension meters or load cells that are installed in the mooring lines.

The AFB system is held in place by the polypropylene lines tethered to the concrete anchors. Selected tether lines will have electronic tension gauges or load meters that report tension data to a centralized monitoring station. The anchors, shackles and lines tethering the AFB will initially be inspected approximately every two (2) weeks and adjusted or repaired as necessary. Once the operating characteristics are better understood, this inspection program will likely be scaled back.

3. Start-up Procedures

During the start-up phase of the project, a computer program is developed for monitoring parameters such as acceptable versus unacceptable tension loads and head differential. These parameters are derived from calculations and observation during the initial phase of installation of intensive monitoring of the AFB. Once the normal or optimal operating characteristics are defined, if an unanticipated and unacceptable load occurs, the load cell relays the strain on the mooring line to the computer which activates or triggers an immediate cleaning cycle and sets off a warning alarm to the operators. The plant operators should observe these changes in the monitoring station and control room and may then inspect the system to determine the cause of the problem and take corrective action as required. In addition a video camera would be placed at a strategic location so that the general configuration of the AFB and the height of the floatation hood (the floatation is drawn deeper into the water if the flow is impeded and would sit somewhat higher on the surface if there were a break in the seal) could be observed from the plant monitoring rooms.

4. Physical Monitoring

Although the AFB system is automated, a number of physical monitoring activities would be implemented to ensure optimal performance:

- Periodic diving inspections to check security and condition of mooring shackles, line abrasion, line tension, curtain integrity, curtain seal and overall condition of system.
- Visual surface inspection on a periodic (incorporated into facility inspection) basis checking for obvious signs of floatation problems (kinking, floating debris, etc.) and condition of shoreline interface.
- Visual inspection via cameras mounted on upper portions of plant for high-level perspective view.
- Monitoring of operator's panel for periodic check of load indications, head differential, "air burst" cycling and other parameters.
- Review of historic information via a data logger system.
- Inspection of on-shore equipment to include condition of supply & control air hoses, mechanical systems associated with compressor, operation & condition of computer control unit.

5. AFB System Maintenance

The maintenance program for the AFB at Contra Costa will be refined and developed as the system accrues operational time and various relevant factors become known. A program of seasonal (when entrainable organisms are not present or in minimal numbers) replacement or refurbishment of a number of AFB elements and units would allow for the gradual upgrade and refreshing of portions of the AFB.

- The mooring lines will periodically be checked for uniform tension and adjusted if required.

- Lines that show signs of chaffing will be replaced and the source of the chaffing identified and eliminated, if possible.

- The integrity of the curtain material will be checked periodically and, should holes be discovered, temporary patches (constructed in advance & stored at the site) will be placed over them.

- Spare "Air- burst™" valves will be maintained and available for switch out should failures occur.

- Hoses will be periodically checked for wear and replaced or repaired as required.

6. Panel Replacement and Inventory

- Two Replacement Systems are Possible

  - AFB Panels may be removed and either refurbished for use in the next maintenance session or, if the panels are substantially worn, they would be properly disposed. This method provides for the complete replacement of the AFB water portion every few years.

  - In the alternative, physical inspection through diving or other means of observations will identify panels or other equipment comprising the AFB that may need replacement. Replacement of panels showing wear will occur in the off-season (during which entrainable organisms are absent or not abundant). In this manner, all worn equipment is replaced as it shows signs of wear.

SE would maintain an adequate spares inventory on site (e.g. 2-3 replacement panels) or will be available on an as-needed basis from local vendors. Unique components parts that may require periodic replacement, based on knowledge of the vendor and experience elsewhere, will be kept on hand (e.g. extra mooring lines and replacement anchors).

7. Conclusions

In summary, SE would implement a physical AFB monitoring and inspection program that should optimize the overall and continued effectiveness of the AFB. This system will, of course, be supplemented by a biological monitoring and sampling program that will verify the effectiveness and efficiency of the AFB at protecting listed species and determining the impact to listed species.